

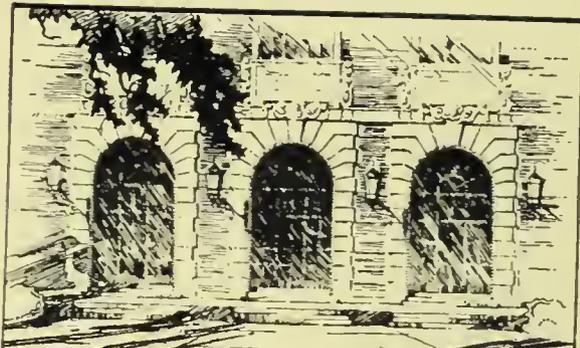
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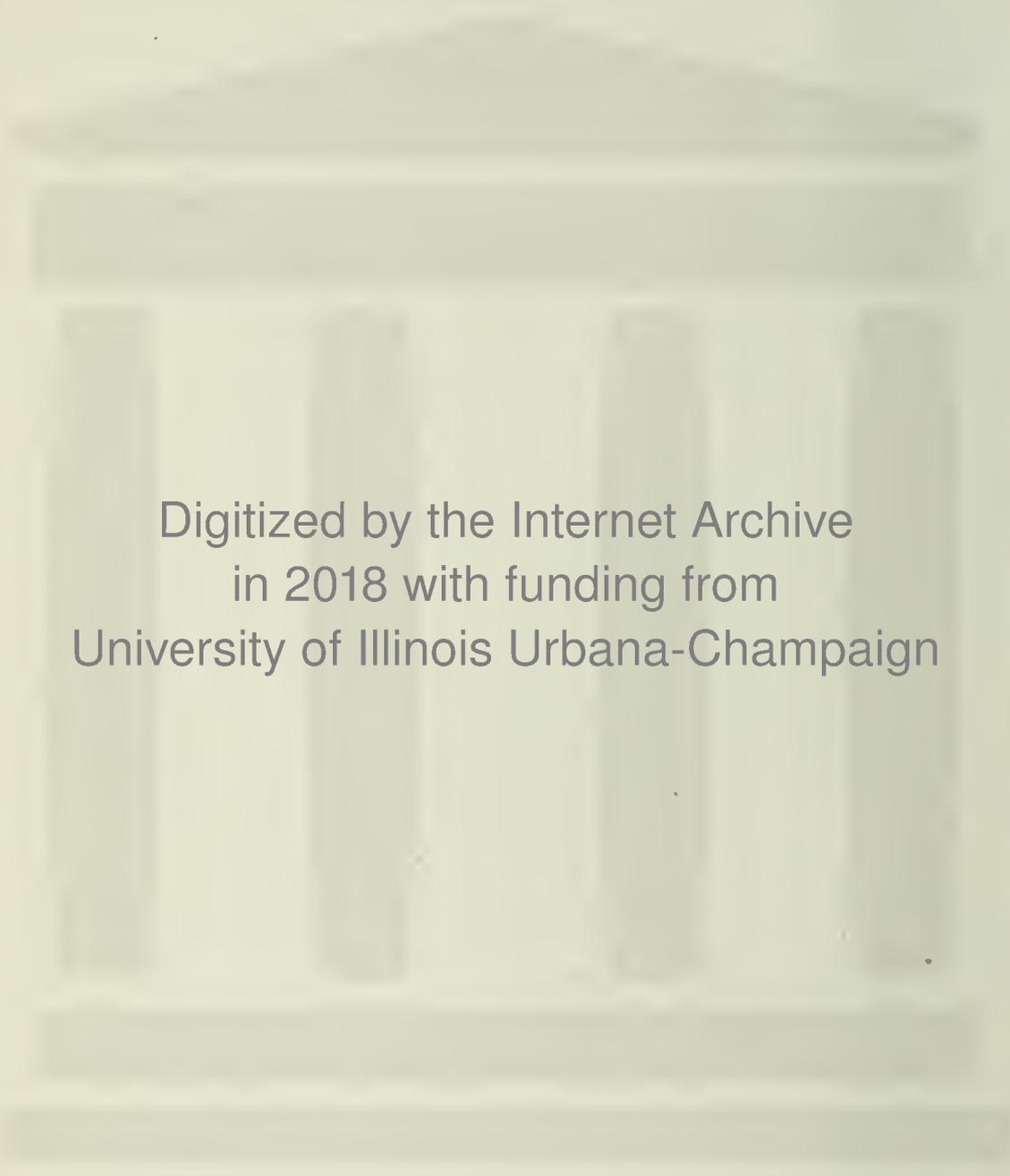
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NINTH REPORT

OF THE

STATE ENTOMOLOGIST

(WALSH, 1. LEBARON, 4. THOMAS, 4.)

ON THE

NOXIOUS AND BENEFICIAL INSECTS

OF THE

STATE OF ILLINOIS.

FOURTH ANNUAL REPORT

BY CYRUS THOMAS, P. H. D.,

STATE ENTOMOLOGIST.

SPRINGFIELD:

WEBER & CO., STATE PRINTERS,
1880.

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LETTER OF TRANSMITTAL.

CARBONDALE, ILL., Dec. 29, 1879.

Hon. James R. Scott, President of the State Board of Agriculture:

DEAR SIR: In compliance with the second section of the act of the Legislature of Illinois, entitled "An act in relation to the State Board of Agriculture," approved May 25th, 1877, I have the honor of presenting herewith my "Fourth Annual Report, as State Entomologist, of the noxious and beneficial insects of the State of Illinois."

This will form the ninth of the series of reports by the State Entomologist, viz: One by Mr. Walsh, four by Dr. Le Baron and four by the present incumbent. The title therefore will be as follows: "*Ninth Report of the State Entomologist on the noxious and beneficial Insects of the State of Illinois,*" in accordance with the plan adopted in my second annual report.

The increasing demand for these reports from year to year, indicates not only a growing interest in the subject of entomology, but also that our farmers and horticulturists are paying more attention to this subject than formerly. This is also probably largely due to the change in the law which now requires the report to be bound with and made a part of the Transactions of the Department of Agriculture of the State. By this means thousands of the reports are thrown into the hands of persons who would not otherwise see them. Another fact indicating the interest in them, is that numerous requests from parties outside of our state for copies are constantly being received. In all cases, where these requests can be consistently complied with, copies are sent to them, and, in all cases except where demanded by strict entomologists, those bound with the Transactions.

Although the number of copies bound separately (two hundred) is not sufficient to supply the demand for them in this form, yet I have deemed it best not to ask for a greater number, as it is desirable the two shall go together, except to entomologists and scientific societies, with whom I exchange.

As no appropriation is made to the entomologist for the purchase of entomological works, I would suggest that a request be made for a certain allowance to your board for that purpose, as such works should properly be placed in the library of your department. An annual appropriation of one hundred dollars would probably suffice for this purpose, if judiciously expended. The agricultural periodicals and works on agricultural topics in the library of your department have been of great benefit to me; and I desire here to express my thanks to your secretary, Hon. S. D. Fisher, and to his assistant, Dr. C. F. Mills, for their many acts of kindness in aiding me therewith.

As my last report was more purely scientific than either of the preceding ones, I felt called upon for an explanation, especially as I have all along argued the necessity of being as practicable as possible.

I gave as reasons; first, the effect of the school law of our State adding the natural history branches to the studies of our common schools; which has been to awaken an interest in natural history in the minds of teachers and students throughout the State to an extent scarcely anticipated by the most sanguine. This largely increased the demand for these reports; and I was informed by teachers that one thing greatly desired was scientific and tabulated arrangements of groups with descriptions of genera and species which might be used as a means of illustrating the method of identifying genera and species.

A second reason was, that in carrying out my plan of devoting a part of my work to a Manual of Economic Entomology, whenever I entered upon the natural history of a group, I desired to complete it so far as was contemplated by the plan.

The present report, on the other hand, is made, so far as possible, practical and hence is arranged on a practical and not systematic basis. The extensive destruction of that valuable, and now almost indispensable esculent—the cabbage—throughout a great portion of our State the past season has called my attention in a special manner to cabbage insects. I have therefore devoted a portion of the report to that subject. That exceedingly injurious species, the European cabbage-worm—*Pieris rapæ*,—which was introduced into North America about 1857, making its first appearance in the vicinity of Quebec, Canada, has now spread over the northern half of our country from the Atlantic coast to the Missouri river. Fortunately it is bringing with it its special parasites, particularly the little Chalcid fly—*Pteromalus puparum* which has so largely aided in keeping it in check in Europe. I may remark here that it is somewhat singular, that this little Hymenopterous insect appears to be a native of this continent as well as of Europe. The large number of the chrysalids of the cabbage worm which appear to be parasitized lead me to hope that next season our gardeners will find this little fly an efficient aid in keeping this imported cabbage insect in check.

Toward the close of the season a new foe to the cabbage made its appearance in the southern part of the State, which, if we judge by its operations during last fall, may prove a formidable pest in the garden. This species, which I have named the *Purple Cabbage-worm*, is the larva of a little Pyralid moth,—*Pionea rimosalis*, Guee—for which we have no common name. Not only were these worms as numerous, in the limited section where they were observed, as the European species, but were, if possible, more destructive and equally tenacious of life. It is possible the long continued warm weather of Autumn brought this pest upon us, and that it may not hereafter trouble us to any considerable extent. If it is a southern species this will most probably be the case, but it is somewhat singular it has never been heard of before if this be so.

The little corn Aphid, which will be found fully described in my former report, has been quite injurious in a few sections in the northern central part of the State during the past season. Although it attacks the tassel, ear, stalk and roots, the injury in this case appears to have resulted almost entirely from the attacks on the roots. I cannot but think that a little timely work would in a large measure

eradicate this species from any field. First by proper rotation of crops, second by thorough fall plowing and turning under, in the fall, some good strong lime. Where this plan has been adopted the result has been favorable.

The chinch-bugs appeared in limited numbers in some localities, in the fall, and there are some grounds to fear that if next season is dry they may develop to such a degree as to do considerable injury. This species has been selected by the National Entomological Commission as one of those to be investigated by that body. In compliance with the request of the Commission, I prepared the manuscript of a Bulletin to be issued under the Department of the Interior; as soon as published I will request a somewhat thorough distribution throughout our State. If a list of names were furnished me by your Secretary they could then be distributed directly from the Interior Department, as that Department would willingly do so if requested and a list of names furnished.

I am inclined to the belief that as a means of counteracting this destructive pest, it would be advantageous to push the cultivation of winter wheat as far northward as this can be done with satisfactory results, as a careful examination of the statistics of losses shows that this variety suffers less from the attacks of this insect than spring wheat.

Considerable complaint reached me early in the spring, and also late in the fall, in reference to the Hessian fly. In some cases specimens sent proved to be this species, but in other cases where I caused fields to be examined, supposed to be injured by this fly, no specimens could be found. I am therefore inclined to believe from evidence furnished that the injury to the fall wheat was caused partly by the wheat aphid though chiefly by the fly.

Complaint from some sections of the State has been received that a new worm has been injuring the clover. So far I have been unable to procure specimens of this worm and hence am unable to determine what it is.

Having been repeatedly called upon during the past two or three years to give information in reference to the parasites infesting domestic animals I have concluded to devote a part of the present report to that subject, although it requires me to travel out of my legitimate field. As the investigation of the history of internal parasites requires a long study of the species, I have necessarily been compelled to have recourse to the works of others on this subject.

It is my intention to prepare as soon as possible a list of useful plants and other substances injured by insects with the names of the species, as a means of ready reference. Whether I will be able to complete it before this report is printed so as to insert it is doubtful.

Since my former report was issued fourteen drawers of the insect cabinet have been filled with properly arranged and classified specimens. This part of the work is necessarily slow but as fast as the specimens can be obtained, after they have been carefully examined and determined, they will be placed in the museum of the Department. A drawer nearly filled is sometimes retained for months waiting until a specimen required to fill out the series can be obtained.

I expect during the coming year to send in the coleoptera, some of which have been awaiting determination.

As ascertaining of habits and life-history of species, and the best means of destroying or otherwise counteracting the injurious ones is

my chief work, the preparation of specimens is necessarily secondary, and although an important part of the duty of a State Entomologist, must not be allowed to supersede the economic work.

There appears to be a growing belief in the minds of many of our practical farmers and horticulturists that as a general rule, though subject to several important exceptions, topical applications in the "long run" are of but little real value. For example, that but little real advantage is gained by the use of Paris green for the *Ten-lined*, or as it is improperly called "Colorado"-Potato Beetle.* Not that this substance fails to destroy those to which it is applied, but that the same end might be attained by use of other means at the proper time, with as little expense of time and money, much less danger, and as little injury to the potatoes.

I tested this on a small scale last summer. Having some fears of this pest, I suggested that in case any farmer observed it in his potato patch, he should, if his force was not sufficient, call on his neighbors for aid and at once destroy entirely beetles, larva and eggs before they had time to develop. Two or three patches were attacked, my own being one of them, the method suggested was adopted and the result was we saved our potatoes with as little trouble and far less danger than by the use of Paris green. By proper care and watchfulness, and commencing work vigorously upon them at their first appearance, trouble, expense and the crops may be saved. I have succeeded the same way the present year (1880).

After killing the Ten-liners (*Doryphora decemlineata*), the "Old fashion species," as it is now usually called (*Epicauta vittata*), made its appearance on my potato plants in abundance. These were readily driven off with brush switches before they had time to do any serious injury, and did not return. A neighbor, in whose patch a swarm, possibly the same one, made its appearance, adopted the same plan with equal success.

In years when they appear in excessive numbers over extensive areas it will not, as a matter of course, be so easy to dispose of them; but united and timely efforts vigorously followed up will, as before stated, do more good and be less expensive in the end than waiting to try doubtful experiments.

There are some cases where combined efforts only are likely to be successful, for example, with the European cabbage-worm, heretofore mentioned.

A gardener, who is watchful and energetic, commences the fight with the butterflies as soon as they appear, but as fast as he kills them new recruits pour in upon him from the neighboring gardens around him. If he should even find an application that is fatal to them and destroys the worms, a second brood from the gardens of his less energetic neighbors comes in upon him in increased swarms and by the time he has these killed his cabbages are destroyed. In this case, unless the parasites of the species afford the needed relief, it will probably be necessary to adopt some method of cultivation such as I have herein suggested, as will enable the cabbages themselves to resist the attacks of these foes. But as before stated there are cases in which nothing but topical applications will answer, and must of necessity be resorted to.

* *Ten-lined*, the name given in my essay of 1862, is the name that should have been adopted.

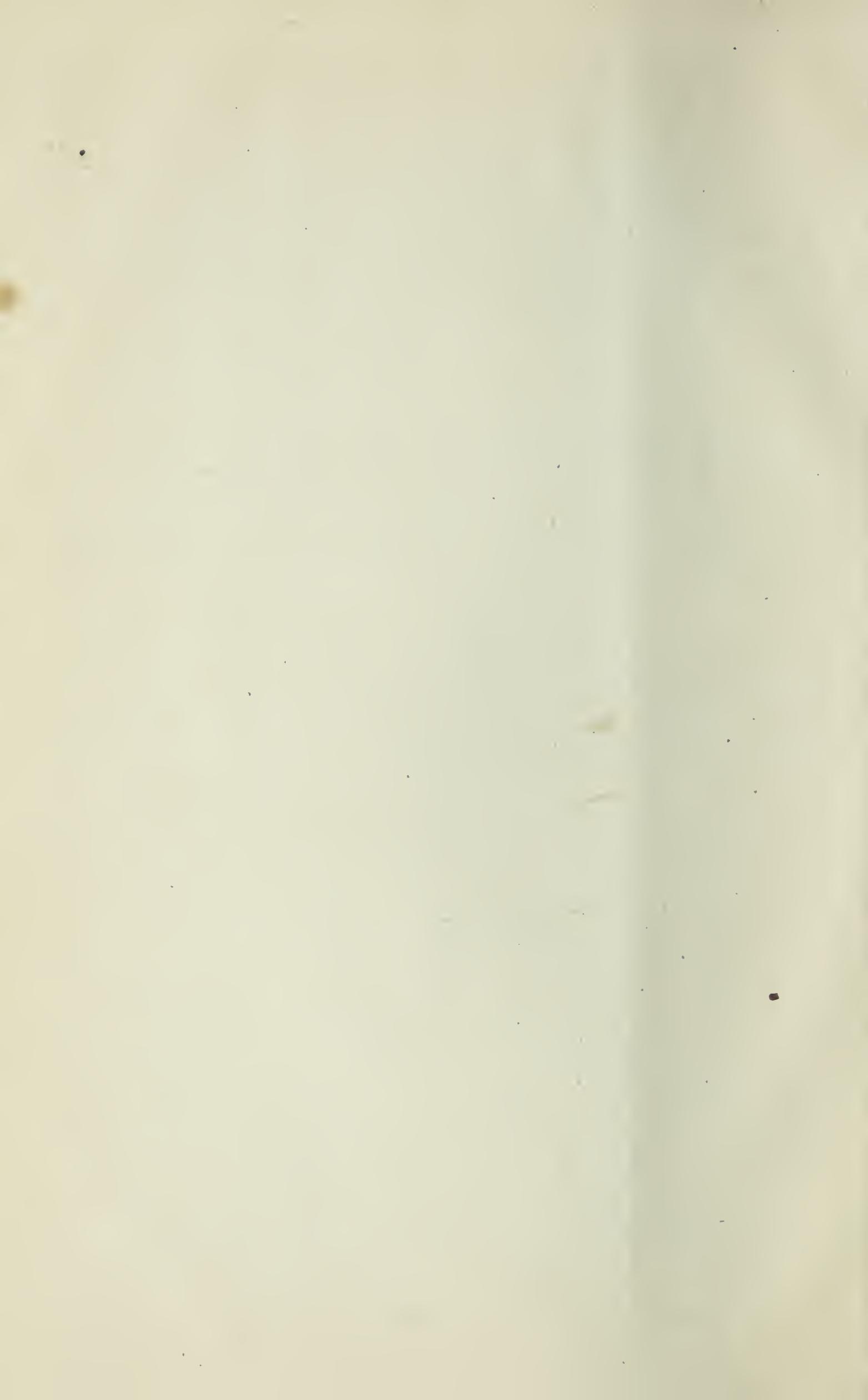
During the past year I prepared a number of large drawings to be used as a means of illustration while lecturing before agricultural societies, clubs, etc. I find this plan highly appreciated and shall endeavor to carry it out to a fuller extent the coming year.

In closing, allow me to say, I find myself under renewed obligations to the Governor, the various State officers, Secretary Fisher and assistant, and your Board for numerous favors received and the evident sympathy they have shown at all times with my work. I am also under obligations to the Illinois Central Railroad Company for an annual pass over their roads.

Very respectfully,

CYRUS THOMAS,
State Entomologist.

P. S. After the foregoing was written I found that the Hessian-fly was abundant in some sections; that the long continued warm weather brought it to the perfect state. I then predicted the wheat would suffer no injury from this pest this spring, which opinion was then published. I am glad to say that while this is going through the press we have the evidence in our wheatfields of the correctness of my predictions.



CABBAGE INSECTS.

Cabbage (*Brassica oleracea*) is one of the vegetables brought into use at an early day, and although not so indispensable as the potato, is nevertheless an esculent highly esteemed, and has assumed an importance that gives it a prominent position, not only in the horticultural catalogue, but also in estimating the productions of our country. I have no statistics by which to estimate its value in this country, but when we learn that in London about one-hundred million heads are annually sold, which, at but five cents a head, would amount to \$5,000,000 we may be prepared to estimate the amount raised in Illinois at a sum worthy of being taken into consideration in estimating the value of our productions.

Just when and where it was first brought into use it is not possible to state now with certainty. A comparatively recent article in Hardwicke's Science Gossip says that the plant from which the varieties in use in England originated, is to be found along the southeast sea-coast of England. But it is certain that some of the varieties were early in use on the western side of the continent; also that kales or coleworts of some kind were long in use in Greece and Rome, as they are frequently mentioned by Greek and Roman writers and even directions given for their cultivation. It is also certain that various species of *Brassica* are found in different parts of the world.

But it is not my intention at present to enter into the history of this vegetable farther than to call attention to the fact that our species is probably a native of a northern maritime country, although the genus is distributed over the temperate climate of Europe, Asia and Africa.

Naturally of a succulent character which has been greatly increased by cultivation, it is thereby rendered more than ordinarily liable to the attacks of leaf-eating insects.

What its original insect enemies were we have no means now of ascertaining with any certainty; but it is evident that the change made in it by cultivation, and its extension over a large portion of the world, has added considerably to the list of its insect foes. As the westward extension of the area of potato cultivation has added to the insect enemies of this vegetable, in this country, so the western and southern extension of the cultivation of cabbage has increased the number of its foes. We may mention as examples in proof of this statement, the Southern Cabbage butterfly (*Pieris protodice*) and the Harlequin Cabbage bug (*Murgantia histrionica*.) The latter, in fact, did not commence its attack until this vegetable began to be cultivated in a certain portion of the Gulf region.

As the chief portion of this plant, as grown under cultivation, consists of its leaves, the attacks of its insect enemies are directed chiefly, and, in fact, almost entirely against these. As the leaves constitute the edible portion of the plant, this fact limits the application of topical remedies to such substances as will not endanger life by

their poisonous qualities. The succulent nature and crisp character of the leaves, notwithstanding the hardy character of the plant, tend also to further limit the use of topical applications, especially such as will discolor or injure them.

So far but little has been done towards finding any other remedies than topical applications, but the experience of the past season in our own State has led many to doubt the efficacy not only of any that have been recommended, but of all remedies of this class so far as counteracting insects that attack the cabbage are concerned. In fact there is a growing tendency among practical horticulturists to place less and less reliance upon such remedies in any case, except perhaps for such tender-bodied and easily destroyed insects as plant-lice.

The loss of cabbage the past season through the operations of the caterpillars of the cabbage butterflies, is well known to every horticulturist, and as these are now the greatest enemies our cultivators of this esculent have to contend with, we will commence our list with them.

FIG. 1.



European Cabbage Butterfly. Male.

FIG. 2.



European Cabbage Butterfly. Female.

THE EUROPEAN CABBAGE-BUTTERFLY. *Pieris rapae*. Linn.

This species which, from the fact that it has been introduced from Europe, has generally received the name "European Cabbage-Butterfly," is usually designated in England the "Small White" or "Turnip Butterfly."

It is beyond all doubt the most injurious cabbage insect with which our gardeners have to contend. As is the case with most of the species which have been introduced from Europe, it is more injurious than any of its native congeners. According to Abbe Provancher it annually destroys about \$240,000 worth of cabbage in the vicinity of Quebec. A correspondent of the *American Agriculturist* for November, 1870, states that the loss from this insect, in the vicinity of New York alone, would amount for that year to more than a million dollars. As I have no statistics in reference to the cabbage production of our State it is impossible for me to estimate the loss occasioned by this insect the past season, but it must have amounted to fully one-half of the entire crop.

It was introduced into North America about 1857, appearing first at Quebec. In 1864 it had not then extended more than forty miles from that city; but in 1866 it was taken in the northern part of New Hampshire and Vermont, and westward beyond Montreal. By means of the railroads it was soon carried to Boston, New York, and southward to Philadelphia and Washington. In 1869 it was reported as common in New Jersey, though Dr. Fitch states that it was first seen in eastern New York in 1870. By 1871 it had travelled as far eastward as Halifax, Nova Scotia, and westward to central New York. It must have reached Illinois about 1876, making its first appearance in the vicinity of Chicago, although attracting no attention until 1877, so far as I can ascertain, when it was found at Maplewood, west of Chicago, in September, having reached this point in its westward march. In 1878 it made its appearance in injurious numbers as far south in the state as Springfield, and a few specimens were taken at Carbondale. Its general spread over the state during the past season has already been referred to. What point it has reached in its westward march I have not learned, but it is more than probable that by this time it has passed across Iowa.

It was probably introduced into this country in some vessel which discharged its cargo at Quebec. Prof. Riley, in his second report on the noxious insects of Missouri, says it was probably introduced in the egg state, on a batch of refuse cabbage leaves which were thrown from some vessel, where, after hatching, the young larvae managed to find suitable food close by. Dr. Fitch, in commenting upon this suggestion, remarks that: "The insect does not remain in its egg state the length of time required for such a voyage. The eggs, however, hatching on shipboard, the worms from them would readily sustain themselves on the leaves, and on reaching port where fresh vegetables could be obtained, the few wilted and decaying cabbages remaining would be thrown away, with some of these worms lurking among the leaves, whereby their race was probably started on our continent."

As this species has been known in Europe from time immemorial, it is a matter of surprise that it was not introduced at an earlier day. But this is to be accounted for by the fact that it was necessary a combination of a number of favorable circumstances should take place before it would be transferred from one continent to another.

Dr. Fitch mentions a somewhat singular fact observed at its introduction into the section of New York in which he resides. "During the fore part of the year 1870, our white butterfly [*Pieris oleraceu*] made its appearance in the usual manner. One or more of them might be seen almost every day flying about our gardens and yards. On the second day of August four white butterflies were hovering about and alighting around me in my garden, when one of them was noticed with much surprise as having a round black spot near the middle of its fore wings. Conjecturing it to be the spotted variety of our white butterfly, and anxious to secure the specimen, I hastened to obtain a net for its capture; but on being approached, to my great regret it flew wildly away. Next day however, two similar specimens were noticed and captured, and on examination were discovered to be the European *Pieris rapæ*. And on the following days these spotted butterflies occurred more and more common, whilst our white butterfly immediately vanished, not one of them being seen either in the gardens or the meadows." A somewhat similar result has attended their appearance in my immediate neighborhood.

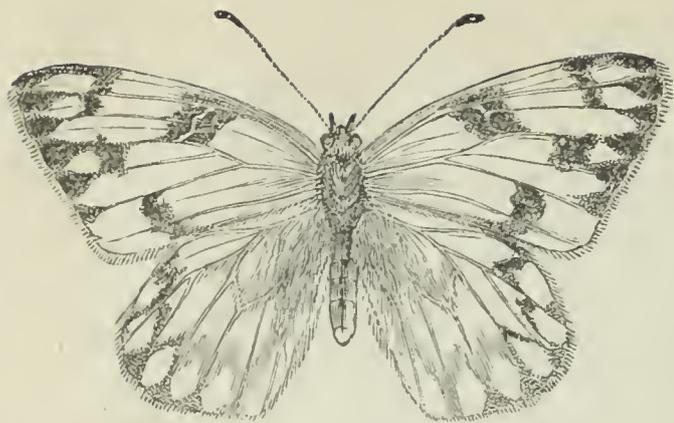


FIG. 3.—Southern Cabbage Butterfly.

Our native species,—*Pieris protodice*, (Fig. 3) is usually very abundant during the summer and early part of the fall. Last fall, as before stated a few specimens of the European species were observed; the native species being quite abundant; but the present season during which the former has been very abundant the latter is seldom seen. It would appear from this that the aggressive foreigner, as the Caucasian among the races of men, is destined to drive from the field the aborigines.

The butterfly or perfect insect of the European species which varies slightly in the two sexes may be briefly described as follows:

The general color a dull creamy white often showing a yellowish cast, the body black above and on the sides, head greenish-yellow; underside of the body yellow; antennæ varied with black and white, the club at the end dusky except at the extreme tip, which is brown. The legs white. The wings of both sexes are of a creamy white above (but marked with black dots as hereafter noted), beneath, the anterior pair white except the tips which are yellow, the posterior pair yellow; on the upper side, the tips of the forewings are marked with a triangular black space; the base of both wings where they join the body are powdered with blue-black. The males (Fig. 1) have the anterior wings each marked above with a single round, black dot near the center; the underside has a corresponding black dot, also a smaller one immediately behind it, near the posterior margin is generally present.

The upper side of the posterior wings usually has a black or dusty dot or mark on the anterior margin near the apex; underside without any spot. The female (Fig. 2) differs only in having two black dots on each of the anterior wings, which are usually larger than those in the males, and are reproduced on the underside; the base of the anterior wings is more widely sprinkled with the dusky shading. The hind wings have the outer margin regularly rounded; abdomen slender.

Length of body about .75 inch; wings expand from 1.50 to 2 inches; usually about 1.75 inch.

I add here Dr. Fitch's lengthy description of the species as observed by him in New York:

"The head is coated over with straight white and black hairs of different lengths, the black ones less numerous on the underside. The eyes are large, protruberant and hemispherical; in the living specimen grayish green, with four rows of movable black spots, the central spot being of a deeper or coal black color; in the dead specimen dull brown and without spots. The antennæ are 0.40 long, and composed of thirty points, which are shorter at each end than in the middle. They are slender and thread-like, with the tips enlarged into a knob of an elongated egg-shaped form, with the larger end outward. Their colors are prettily arranged in new and unruffled specimens, the outer and undersides being white; on the upper side a continuous black line; on the inner side a row of long oval dark brown spots, one on each joint extending from its base nearly to the tip; these spots separated from the black line above a slender white line,

which is widened toward the apex of each joint, and there sends downward a transverse band connecting this white line with the white under side. The knob is flattened or spoon-shaped and black on the concave inner side, white on the lower edge and outer side; the upper part of this side being sprinkled with black scales which sometimes form bands of this color, the tips pale yellow. The thorax is black and clothed with soft hairs of a white or bluish white color. The abdomen is black and covered with white appressed scales, less dense upon the back; its under side white and coated with white scales. The legs are covered with white scales, and the under side of the thighs with white hairs; and there is frequently a black stripe on the thighs and one or two slender black lines on the shanks and feet. The wings are white and at their bases dusted more or less with black scales. The fore wings frequently have black scales sprinkled along their outer or costal border its whole length. At their tips is a large triangular grayish black spot, which is longer on the outer than on the hind side, and on its inner side straightish, frequently with a concavity towards its inner end. In the female this spot is larger, but effaced on its inner end, whereby it has more of a squarish than a triangular form. Slightly beyond the center of these wings is a large black dot or round spot; and between this and the inner edge, in the female, is a second spot, which is usually smaller and less regular in form, with its edges more indefinite. And in this sex is frequently a faint gray streak on the inner border of these wings, extending from opposite the inner spot forward toward the base. The hind wings in both sexes have a black spot on the outer margin a little back of the middle, which is smaller than those on the upper wings, and its more indefinite. On the underside, the forewings are white and sprinkled with black scales at the base and along the outer border sometimes to the middle. Along the innerside of the rib-vein toward the base is a broad stain of yellow, more distinct in the females. The tips are pale yellow, and in both sexes there are two black spots, corresponding with those on the upper side in the female, but commonly smaller. The hind wings are pale yellow, and dusted over with small black scales, which are more numerous toward the base; the outer edge is brighter yellow near the base, and no vestiges of the black spot of the upper side are here visible in either sex."

Curtis's description of the species as observed in England is as follows:

"The *male* is white, the superior wings have black tips dusted with white, and the inferior wings have a black spot on the upper edge: The *female* is similar, but has two large black spots likewise beyond the center of the superior wings; under side of same white, the apex yellow, and two black spots beyond the middle, the lower one sometimes nearly obliterated; inferior wings yellow, freckled with black; length of male, 8 lines; expanse about 2 inches; the female is larger and sometimes of a duller color; but I possess a male taken near Oldham, in Lancashire, which has all the wings of a bright yellow color."

The female butterfly deposits her eggs singly here and there usually upon the under side of the leaves, not in clusters as do some other species of the same generic group; but she does not confine herself to this part of the leaf as the edge and upper side are often

selected especially when the insects are abundant. To the natural eye they appear like little pale yellowish green grains, being so small that they pass unnoticed unless the attention is turned especially towards them. If examined by a magnifying glass they will be found to be conical, or shaped like the old fashioned sugar loaf, the larger end or base which is flat, being glued to the leaf; the apex is also cut squarely off. Their surface is glossy and beautifully fretted with alternating minute ribs and furrows; the ribs, of which there are usually about twelve, run lengthwise, with intervening furrows; it is also striated transversely with very fine impressed lines regularly placed. The length is rather less than one-twentieth of an inch, the thickness about one-fourth the length.

The time required for the eggs to hatch varies somewhat, but is usually about six or seven days. The little pale yellow glossy caterpillar, which is less than one-tenth of an inch long when it first escapes through the opening it has gnawed in the shell, not satisfied with release from its prison, as the first act of its free life devours the shell. This habit appears to have been first noticed by Harold and is mentioned by Westwood, Curtis, Fitch and others. Dr Fitch describes this operation fully as observed by him as follows:

“The first act of the worm is to eat the shell of the egg from which it has been hatched. It first gnaws an opening on one side from the top nearly to the base, and then very slowly nibbles the sides of this opening, and the base of the shell, until it is so cleanly consumed that no indications of the spot where it was placed remain. In the instance observed, the worm was occupied five hours in eating its shell. When this is accomplished it remains at rest for a few hours.”

His further observations in reference to the habits of the young caterpillar are so clearly stated and so interesting that I make no apology for introducing them here.

“Its second act is to weave a mat or carpet to give it a more secure foothold upon the leaf. Applying its mouth to the surface of the leaf and moving it from side to side, it spins therefrom a thread of silk of most extreme fineness, which it fastens to the surface, crossing it in every direction, until it forms a thin film, which to the eye appears like a small glossy spot very visible in a particular reflection of the light, looking as though the leaf had been slightly touched with varnish. If nothing occurs to drive it therefrom, this spot becomes its residence for a few days. And wherever it takes up its abode subsequently, it constructs a similar mat, into the threads of which it can catch the minute hooks of its feet, to render its standing more secure than it is upon the naked surface of the leaves.

“It next begins to feed upon the leaf, some six or twelve hours after it has finished eating the egg shell. At some point slightly outside of the edge of the mat on which it is standing, it eats a round hole, the size of a small pin head, into which it gradually sinks its head deeper and deeper, until it passes through the parenchyma of the leaf to the skin of its upper surface. As yet it is so small that the eye only perceives it to be a minute, cylindrical, pale, yellow worm, usually lying straight and motionless on the leaf. But as it feeds on the green pulp of the leaf, its body acquires a green color and slowly increases in size, growing about one-thirtieth of an inch daily.

“Foreign authors state that in getting its growth this cabbage worm molts or casts its skin ‘several times.’ I can say with perfect confidence, it is only three times that it molts. When it first comes from the shell it is extremely soft and its skin admits of much distention before it constricts the worm to such a degree that it requires to throw it off. It is not till it has grown to double its first size and is 0.12 to 0.15 long that it casts off its skin the first time. It then feeds and grows till it has again doubled its size and is 0.25 to 0.30 long, when it molts a second time. It again doubles its size and becomes about 0.50 long, when it makes its third molt; and the skin which it then acquires it retains till it reaches maturity, throwing it off only when changing into its pupa form. This is the uniform course of these worms, as I have observed in a number of instances. The only aberrations I have noticed in these moltings are, that one of them is sometimes deferred till the worm is much larger; yet this does not appear to affect the other moltings of the same worm, for these occur as usual. Thus in one instance the second molting did not take place until the worm was 0.38 long; yet the third occurred when it was 0.53. In another instance the second molting took place when the worm was 0.30 long, yet the third was deferred until it was 0.64”

The almost uniform color is pale green; the full grown larva is a little over an inch in length and about one-sixth of an inch in diameter. Dr. Fitch says they are quite uniformly an inch and one-tenth in length; but as a general rule I have found them in Southern Illinois oftener nearly an inch and one-fourth in length. The constrictions between the segments are not very distinct, but the body appears rather to be divided into numerous little rings, of which I find about six to the segment. They are covered everywhere with fine short whitish hairs; interspersed among these are minute black conical tubercles or elevated points. By examining closely with a pocket magnifier, it will be seen that these black points are arranged in rows along the transverse ridges into which the segments, as before stated, are divided, the intervening, transverse, impressed lines being smooth and without hairs or tubercles.

The head is rather small and is also hairy; the body tapers very slightly toward each extremity; there are six true legs, eight abdominal and two anal fleshy pro-legs.

The general color, which is nearly uniform throughout, is often described as a pea-green; while this is sufficiently correct for general purposes, yet if we examine them closely we find that the green has a slightly bluish cast, more apparent on the underside, which is paler than the dorsal surface. There is usually a narrow yellow line along the middle of the back, but this is sometimes partly obliterated, and one now (Nov. 24) before me, and alive, shows scarcely any sign of it, a mere trace being visible on the first and second segments, and this so faint as to be seen only with a glass under certain reflections of light. On each side near the lower margin there is a row of bright, yellow dots, one on each segment a little behind the breathing pore.

When young their skin is somewhat glossy and shining, but when they reach maturity the surface assumes a velvety appearance, given it by the numerous minute pimples and short hairs with which it is covered.

The following descriptions by others are introduced here for the purpose of enabling examiners hereafter to determine questions as to local varieties.

Curtis, in his *Farm Insects*, briefly describes it as follows:

The eggs are "not unlike those of *P. brassicae* in form and sculpture, but the caterpillars are totally different, being green and so densely covered with minute hairs as to be velvety; they have a yellowish stripe down the back and another along each side, the venter being of a paler brighter green; they are often more than an inch long and about as thick as a crow quill."

His figure shows distinctly the lateral stripe.

Goureau's description, in his "*Insectes Nuisibles*," is evidently copied entire from Curtis.

Boisduval, in "*Entomologie Horticole*," describes it very briefly, but mentions three longitudinal yellow lines, one along the back and one along each side just above the feet.

Stephens, in "*British Entomology*," describes the caterpillar as "green, with a pale line on the back, and a whitish line, often punctured with yellow, on each side."

But the most complete description is that given by Dr. Fitch, in his Thirteenth Report; as follows:

"When examined with a magnifying glass, the surface of these worms is found to be everywhere bearded with fine short whitish hairs, those upon the back shorter, and on the young worms black and interspersed with small stiff bristles. These hairs arise from numerous minute black elevated points, with which the surface is everywhere studded, the larger points being arranged in transverse rows, a row upon each of the elevated ridges into which the segments are divided by impressed, slender transverse lines. In addition to these black points, a few pale dots or minute warts are more or less perceptible, one appearing on each side of the middle of the back, on the second elevated ridge of each segment; another lower down on each side, upon the fifth ridge, and some others below these. But on each of the three first rings these pale dots are arranged in a single transverse row, on the first elevated ridge, three dots on each side, placed equidistant from each other. Along the middle of the back is a pale yellow line, which is sometimes very faint, or visible only on the anterior rings. Low down on each side is a row of dots of a brighter yellow color than the line on the back, one on each segment, placed a little back of the breathing pore. The breathing pores are small, broad oval, dull white, inclosed in a black ring, which is bordered with yellow, this border being more broad on the fore side and sometimes wanting on the hind side. The head is spheroidal and as broad as the neck, green, and clothed with hairs. The legs and pro-legs have the same green color as the body."

Instead of commencing at the margin of the leaf and eating inward, as is the habit of many leaf-eating insects, it riddles it with holes, gradually enlarging these where the worms are numerous until all that portion between the veins is consumed. Although they will commence operations on either the upper or the under side of the leaf, yet my observations lead me to believe they prefer commencing on the upper side. Although they bore into the incipient heads, yet I did not find this habit so general as I supposed, from what I had read in reference to them; in fact, I seldom found them making their

way into well-formed, compact heads. When the heads are forming, and they commence work on the outer clasping leaf, this appears to have the effect to cause it to partially open or withdraw from the head, which enables the worm to work more freely. This also has a tendency to prevent the cabbage from heading.

Notwithstanding the butterfly appears to be aggressive in its nature, in this country at least, driving away by its simple presence or in some other way, our native congeneric species, the larva on the other hand is of a quiet and peaceful disposition, avoiding intrusion upon each other and upon other insects. It is with much hesitancy it passes from its leaf to another; and Dr. Fitch noticed that if an aphid was located on a leaf near where the worm was feeding, the latter would without encroaching upon or in any way molesting it leave untouched a portion of the leaf a half an inch or more in extent around the aphid. I have observed an aphid walking freely over one of them without it making any effort to disturb or cast it off.

Although apparently so tender and delicate in its organization it is exceedingly tenacious of life; acrid substances which will readily destroy many other caterpillars appears to have but little or no effect upon it. I have noticed them eating away though covered with pulverized lime; Dr. Fitch has observed the same thing with reference to white hellebore, and yet this will readily destroy the currant worm or saw-fly larva. The same author also states that on one occasion he found one frozen in a cake of ice which after being thawed out revived and completed its transformations. How it is possible for an insect apparently so tender and composed almost entirely of fluids, to survive under such a degree of cold is a difficult problem to decide. Cabbage is capable of surviving very severe cold, and hence we presume is a native of a northern climate, it is therefore possible that it communicates this property to the worm which feeds upon it.

When it has completed its growth, admonished doubtless by some peculiar feeling that it is about to undergo a change, it becomes uneasy and commences running to and fro seeking some place of retirement where it may safely pass the pupa or chrysalis state. For this purpose it selects, if it be found, some place above ground, that is somewhat protected, as the underside or margin of a rail, board or projecting substance, apparently preferring dry woody substances. I have observed them climbing the sides of a two-story house to the eaves before content with the position. Having found a place that is satisfactory, the first act of the caterpillar is to spin a little mat on the surface, in which it can fix the hooklets of its feet as a means of support. It next spins a strong silken cord across the middle of its body fastening it firmly on each side to the plank or rail on which it is placed. Soon after this operation is through, the worm commences contracting in length, especially its anterior portion; the color also changes from the bright green to a dull or dirty yellowish-green approaching more and more to the dull gray of the pupa. The outer skin during this time, is loosened from the pupal skin within which by this time it is completely formed; it now gives way before the pressure of the insect within and splits open along the head and front part of the back. The pupa proper now appears and having relieved itself of the old larval skin, assumes the chrysalid form of the species.

The pupæ vary in color not only according to age, but after they have fully completed their pupal growth; almost every color from a dull yellowish green to an ash gray may be encountered. A light gray, with numerous black points appears to be the most common; those which are parasitized are paler than those that are living. The length varies from about .70 to .80 of an inch; a perfect one now before me measures exactly .75 inch, the precise measurement given by Dr. Fitch as the usual length. The angles in the throacic region are sharp and somewhat laminated; the two anterior lateral ones presenting a single prominence, the posterior ones two prominences; the anterior end is armed with a short spine which projects forward.

The length of time that the summer brood remains in the pupa state varies considerably. Dr. Fitch gives the length of time six specimens of the summer brood remained in this state, partly from his own observations and partly quoted from the statement of Joseph L'Admiral, as follows:

DATES.

Entered pupa state.	Butterfly appeared.	Length of pupa state.
July 8.....	July 19.....	11 days.
July 20.....	August 5.....	16 "
August 19.....	August 26.....	7 "
August 22.....	September 2.....	11 "
August 29.....	September 7.....	9 "
September 4.....	September 23.....	19 "

Professor French informs me that those he reared remained in the pupa state generally from six to eight days.

My observations differ somewhat from either of these, showing the time to be shorter. A number of full grown worms, about twenty, were collected July 17, which were about to enter the pupa state; by the evening of the next day all were chrysalids. On the 22d of the same month, five days afterwards, a few butterflies made their appearance; the 23d a large portion appeared, and in a day or two more, all not parasitized had completed their transformations.

It would appear from this that the pupa state is considerably shorter in the latitude of Southern Illinois than in that of New York.

As the insect winters in the pupa state, the chrysalids of the fall brood are not, as a matter of course, transformed into butterflies until the following season, from March to May, according to the latitude and season. The fact that one of Dr. Fitch's specimens entered the pupa state August 21st, and the butterfly did not come out until December 8th; and one of L'Admiral's which pupated September 5th, did not come out until the 28th of May following; shows that in the same section some may be double-brooded while others may be but single-brooded. Or in more southern latitudes some double brooded and others three brooded.

Miss Smith, in her address delivered before the Wisconsin Horticultural Society, at Green Bay, states that "the butterflies" (of this species) are generally supposed to hibernate during the winter months(?) I presume that she intended to convey the idea by this language, that it is generally supposed this insect hibernates in the perfect or butterfly state; so far, I have been unable to find any authority for this

statement, as all the writers who describe the habits of this or the congeneric species, state directly or indirectly that they hibernate in the pupa or chrysalis state. This has been known in Europe from the days of Harold, and in America, the same fact has been observed from the time of its discovery to the present.

This species is generally understood to be two brooded. The perfect insect was taken here last spring early in March; and there are a few worms now (Nov. 26,) on the cabbages. The butterflies have been more or less numerous all summer, but they appeared to be most abundant at three periods; the spring brood in March and April; the July brood and September brood. Hence I feel quite certain that we had three broods in the southern extremity of the State last year.

Natural Agencies which assist in its destruction.—Fortunately for the gardener this and the other species of cabbage butterflies are subject to the attacks of certain parasites which aid very materially in their destruction.

Curtis in his "Farm Insects" describes and figures several species of parasites which prey upon the three species of cabbage butterflies found in England, and shows how thoroughly they keep in check these troublesome worms. These are chiefly minute ichneumon-flies of the Chalcid group, some of which deposit their eggs in the eggs of the butterflies; another punctures the caterpillar and deposits its eggs in its body, while another places its eggs on the outside of the chrysalis so that when hatched the little grubs can work their way into the interior. The last of these, the *Pteromalus puparum* of Linneaus is found also to be a native of this country; and since the advent of the European cabbage butterfly which, we are now describing (*Pieris rapæ*), has manifested its desposition by attacking the chrysalis. It was not known that this Chalcid was a native of this country, but when observed, was supposed to be an importation which had been brought over from the eastern continent with its host, until Dr. Packard, by comparison of specimens found here and in England, ascertained they belonged to the same species.

This little Hymenopterous insect, rather less than one-tenth of an inch long, is wasp-like in form, with four delicate transparent wings, very slightly reflecting the prismatic colors, the anterior pair with a single short, dull yellowish nerve; the head very short and broad; the body of the female is a blackish green, that of the male somewhat pale-green.

The following more exact description is by Dr. Packard:

Description.—The male of the *Pteromalus* is a beautiful pale-green fly, with the body finely punctured and emitting metallic tints; the abdomen, or hind body, is flat, in dried specimens with a deep crease along the middle of the upper side, and it is much lighter in color and with more decided metallic reflections than in the rest of the body. The antennæ are honey-yellow, with narrow black wings. The legs are pale honey-yellow. It is .08 to a tenth of an inch in length.

"The body of the female, which would be thought at first to be an entirely different kind of an insect, is much stouter, broader, with a broad oval abdomen, ending in a very short ovipositor, while the underside of the body near the base has a large conical projection. It is much duller green than the male, and the body is more coarsely punctured. The scutellum of the metathorax is regularly convex, not keeled, in both sexes. The antennæ are brown, and the legs brown,

and the legs brown; becoming pale toward the ends; the ends of the femora being pale, the tibiae pale brown in the middle, much paler at each end, while the tarsi are whitish, though the tip of the last joint is dark. It is from a line to a line and a third in length.

"The larva is a little white maggot about a sixth ($\frac{1}{6}$) of an inch in length. The body consists of thirteen segments, exclusive of the head, and is cylindrical, tapering rapidly toward the head, while the end of the body is acutely pointed. The chrysalis is whitish, the limbs being folded along the under side of the body, the antennæ reaching to the end of the wings; the second pair of legs reaching half-way between the end of the wings and the end of the abdomen; while the tips of the third pair of feet reach half-way between the second pair of feet and the end of the abdomen. It is from a line to a line and a third in length."

According to Curtis the female deposits her eggs upon the outside of the chrysalis of the butterfly as soon as the caterpillar has cast off its skin, and while it is yet soft and tender and exhausted by the severe change which it has undergone. These eggs soon hatch, and the little grubs at once eat their way into the body of the chrysalis, the interior of which at this time is in an almost liquid state.

Mr. Curtis does not state whether this is given upon his own observation or the statements of others.

While not without a parallel it does not appear to be by any means a common habit of the parasites of this group to select such place for depositing their eggs; and so far I have failed to find any eggs or appearance of eggs on the pupa case of parasitized specimens.

It is also an unsettled point among entomologists as to whether this parasite operates on its victim in the larval or chrysalis state. That the eggs are not deposited on the external surface of the pupa may safely be taken for granted until careful observation shows it to be otherwise. The negative evidence is against this mode; the usual habit of these parasites, in this respect, is against it; the fact that only the soft, tender and recently transformed specimens are selected, indicates the contrary. For example, according to Kirby and Spence (Introd IV 233) *Cullimome puparum* commits its eggs to the chrysalis of *Vanessa urticae*. The moment this caterpillar quits its skin to assume that state, while it is yet soft, they pierce it and insert their eggs.

The following statement by Mr. Saunders, editor of the Canadian Entomologist, in the October number (1878) of that periodical indicates, so far as a single observation bears upon the question, that the *Pteromalus puparum* follows the usual habit of its congeners, to-wit: deposits its eggs in the caterpillar.

"A few days since, while watching some of the full grown larvæ of the cabbage butterfly which were feeding on Nasturtium leaves, I was much gratified in witnessing the method of attack which this parasite adopts. Settling herself quietly down on the back of the caterpillar, near the terminal segments, with her head towards the caterpillar's head, she paused awhile; then with a sudden movement of her ovipositor, so quickly that the motion almost escaped detection, she thrust an egg under the skin of her victim. The caterpillar seemed startled, and quivering, jerked its head and anterior segments

suddenly about and then quieted again; the little tormentor meanwhile sitting perfectly composed on the spot where she first settled. Presently another thrust was made, followed by further uneasy movements of the larva, and in this manner, in the course of a very few minutes, quite a number of eggs were deposited. The caterpillar did not seem to be conscious of the cause of its troubles, nor, indeed, of the presence of its enemy, excepting when the thrusts with the ovipositor were made. On drawing a little nearer for the purpose of better observing this interesting operation, the tiny creature took alarm and flew off. Further examination revealed the presence of several more of these little friends, busily searching for further specimens to operate on. The eggs deposited soon hatch into little grubs, which eventually devour the body of their victim, and after it has entered the chrysalis state, eat small holes in the chrysalis, and thus make their escape."

The number of these maggots which live in one chrysalis is often very great, sometimes amounting, according to Curtis, to as many as two or three hundred in the pupa of *P. brassicæ* which is larger than that of *P. rapæ*.

It is proper to remark here that according to Mr. Meldola (*Pro. Ent. Soc. Lond.*, 1876—XXXV) it is *Pteromalus imbutus* that is parasitic on *P. rapæ*. But that the species which infests *P. rapæ* in this country is *Pt. puparum* has been positively determined by Dr. Packard who has compared specimens obtained in this country with European specimens. He states that the usual number found in a single chrysalis of *P. rapæ* is from fifteen to thirty which accords with my observations; but Mr. Couper (*Can. Ent.* VI. 37) states that he has counted as many as ninety-five in one chrysalis.

In the pupa shells which I have opened, some of which are now before me, I find that all the parasites have not escaped, but in each there are more or less dead. As these have passed from the pupa state it is evident they have not been attacked by a second parasite; the question then arises, Have they failed to perfect their organization and acquire sufficient strength to cut their way out for want of sufficient food? Judging from Mr. Curtis' observations this would seem to be impossible, but we must bear in mind the fact that his statements apply to the larger chrysalis of *Pieris brassicæ*.

These little parasites, as may be inferred from what has been stated, undergo their transformations in the body of the chrysalis or pupa; the perfect flies coming out of the summer brood in about two weeks; but those in the fall brood do not make their appearance until the following spring.

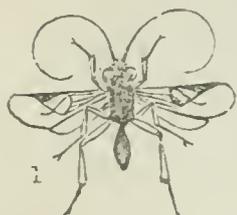
Their multiplication is so rapid that when they make their appearance early in the season where the butterflies prevail, it will be found that the larger portion of the fall pupæ are parasitized. Dr. Packard states, that out of one hundred and ten chrysalids handed him by Mr. Putnam in September, (1876) all but two were infested. The infested specimens I have examined were obtained chiefly in the northern part of the State, and selected because they were parasitized, hence I am unable to state the proportion.

Although the parasite has made its appearance in my immediate section, it came too late to affect any but the last brood of the past season.

The infested chrysalids of the butterfly may usually be distinguished by the livid and otherwise discolored and diseased appearance of the body.

I do not know that these parasites select any particular point of the chrysalis shell at which to make their escape, but in those I have observed, the place of exit appears to have been generally at or near the point where the abdomen joins the thorax.

FIG. 4.



*Microgaster
militaris.*

In Europe there is a small Chalcid species—*Microgaster glomeratus*, Linn., which attacks the caterpillar, depositing thirty or more eggs in its body, the maggots hatch from these, feed internally upon the worm, weakening it but not destroying its life until they are ready to transform into pupæ—then it dies, and they, yet in the larval state, make their way through the skin and spin little elongate-oval silken cocoons, in masses, beneath and around it.

Although this species, so far as I am aware, has not yet been observed infesting these cabbage-worms in this country, yet cocoons somewhat similar to those made by it have been found about the caterpillars of *P. rapæ*. I insert here a description of it, copied from Curtis:

“It is black and thickly punctured; the horns are thread-like, longer than the body in the male, shorter in the females, and composed of eighteen joints or upwards; the eyes are lateral, with three little eyes or ocelli upon the crown; the abdomen is shorter than the thorax, depressed, linear, smooth and shining; the basal segment is a little narrowed, with the edges on the sides dirty white; ovipositor concealed beneath the abdomen; the four wings are very transparent, iridescent, with a distinct pitchy-colored stigma on the superior; the nervures lighter, the areolet open externally; legs bright ochreous, hinder-thighs black on the upper edge, darkest at the apex, tips of their shanks and tarsi brownish, the apex only of the four anterior brown; length a little more than one line; expanse $2\frac{3}{4}$ lines.”

According to this author, the little cocoons are bright yellow. I have found this season, upon the cabbages where the worms had been at work, similar little cocoons, except that instead of being bright yellow, they are of a creamy white; but I have not yet seen the perfect insect.*

Mr. Provancher, of Quebec, was the first to call attention to another parasitic fly, which belongs to the same group as, and resembles, the common house-fly. This is a species of *Tachina*, and the maggot, which resides in the body of the cabbage-worm, living on the fatty portions, is, according to Dr. Packard, flattened and sub-cylindrical, with both ends of it rounded much alike; the mouth-parts partly aborted, there being only two retractile horny mandibles, by which the fatty portions of its host are eaten.

There are other Ichneumon flies, which I am inclined to think are, at least occasionally parasitic upon the worm, as I have noticed them frequently about them and on the cabbages where the worms were at work. One, apparently a *Microgaster*, and another, supposed to be a *Pimpla*. Some fifty or sixty cabbages in my garden were devoted to

*Since this was written, Mrs. Thomas has succeeded in obtaining the perfect insect, which appears to be identical with *Microgaster militaris*. (Fig.4)

the worms the past season, for the purpose of experimenting with them; on some the worms were quite numerous up to November, now it is almost impossible to find a chrysalis, while those bred in cases have long since passed into the pupa state, and most to the perfect insect. The question therefore arises, what has become of the worms on the cabbages?* Have they been transformed into butterflies by the warm weather? or have they been destroyed by parasites and other enemies? A few butterflies were seen as late as the first part of November, but not after all the worms had disappeared. Dr. Fitch noticed a spider which he names the "cabbage spider," (*Theridion brassicæ*) feeding on the young caterpillars. This is about one-fifth of an inch long, of a waxy white color, with two black, parallel lines along the middle of the front part of the body; the legs long and slender.

He also mentions and describes another species the "Underleaf spider," (*Theridion hypophyllum*) about the same size as the preceding, with the front part of the body and thighs a bright cherry red; its globular abdomen black and shining.

We may add also as natural enemies, insect-eating birds and domestic fowls; the latter especially, are efficient aids, as will be found by allowing a hen or two with flocks of chickens the range of the cabbage patch, a plan I carried out in 1878, but neglected in 1879.

Artificial Remedies.—Old Vincent Kollar in his work on *Injurious Insects*, says "The best way to destroy them is picking off and killing the caterpillars as well as the pupæ, as far as it is possible; the latter are found attached to adjacent trees, hedges and walls."

Curtis, in his *Farm Insects* says "There are several methods of reducing their number and checking their increase; the best is to look in the winter for the chrysalids, which are concealed under the ledges of walls, pailings, doors, window-sills, on bushes, in hedges, on the trunks of trees, etc., and crush them, but on no account to destroy the dark brown colored ones, which are full of the parasitic *Pteromali*. As the spring advances a ring or bag net may be used to catch the butterflies; and when the caterpillars are large enough to be seen, hand picking is neither difficult nor laborious; when they attack the seed crops, shaking the stems might prove useful, provided troops of ducks were to follow and pick up the caterpillars; or dusting the plants with hellebore powder, fresh and genuine would be worth a trial, as it is very effective in some instances."

Boisduval in his *Entomologie Horticole*, gives but one method, that of catching the butterflies with insect nets.

Duponchel, in his *Iconograph of caterpillars*, says the most efficacious way of destroying them will be for the gardeners to employ the children in capturing for slaughter all the white butterflies which are seen flying around their cabbages, as these are mostly females seeking places to lay their eggs; and that by slaying one female before she begins to lay, we destroy an entire generation of caterpillars. He also recommends searching for and destroying the eggs and pupæ.

Dr. Fitch also recommends employing children to capture the butterflies, and placing pieces of boards between the rows of cabbage, elevated two or three inches above the ground, as places for the worms to pupate, when the pupæ can from time to time be collected and destroyed. He also suggests searching the cabbage leaves over and

* Many chrysalis were afterwards discovered on the weatherboards of the various out-houses.

cutting asunder all the worms found, with a pair of scissors. He thinks topical applications of poisonous substances such as hellebore, etc., of no particular value.

Prof. Riley repeats the recommendation to capture the butterflies; and also recommends trapping the pupæ, by placing boards between the cabbage rows. He adds that the "saponaceous compounds of crecylic acid are effectual, and without objection as to poisonous qualities."

Subsequent experiments have shown that most, if not all the topical remedies proposed fall far short of affording any substantial relief from the depredations of this pest. Of these I tried the past season, salt, brine, powdered lime, ashes, lye and alder decoction, lime and brine had the least effect, the worms eating away, apparently, without inconvenience when coated over with lime; ashes had very little more effect; a lye made by putting fresh and strong ashes in water and using it at once, proved more effectual than anything else I tried. Salt, where it could be made to reach them, was more effective than the brine. Alder decoction, which, in the hands of some other experimenters, proved of value, was tried too late to give it a fair test. Others have used decoctions of dog-fennel and of knotweed, as they thought, with favorable results; and others dilute carbolic acid. Hot water has long been recommended. In one instance within my knowledge, powdered black pepper was tried, and for a short time did check the worms, and the cabbages, as I afterwards observed generally formed good heads.

Although the list of materials used is a rather long one, yet we are not prepared to say there is no topical application that will destroy the worms without materially injuring the cabbage. The fact that the species has long been injurious in Europe, without such substance being discovered, it is true, renders the likelihood of such discovery very doubtful; and therefore we should seek some other means of counteracting the pest.

I tried the experiment of catching the butterflies, and am satisfied that children from ten to fourteen years of age can soon be taught to do this with ease.

The butterfly moves heavily and rather slowly, alighting especially on cruciferous flowers; a small bed of radishes here and there, if allowed to run to seed, will attract them, and they may then be caught without running among the cabbages, which is one objection to this method of relief. For this purpose a circular ring of heavy wire about twelve or thirteen inches in diameter, with the ends of the wire fixed in a tin socket for the handle, and a sack of musquito-bar or very thin open muslin, about as long as twice the diameter of the ring, with a handle four or five feet long, will answer the purpose very well.

The butterflies are most numerous in the hot part of the day when it is clear and the sun is shining brightly.

I have never heard the question asked, "where do the butterflies rest at night?" nor does it appear that any attention has been paid to this subject. I presume they scatter and find resting places on the bushes, trees, shrubbery, etc., as other species, as it is scarcely probable they would congregate. Still it is barely possible, though not at all probable, that a solution of this question may afford a means of diminishing their numbers.

My experience does not give promise of much aid from the attempt to destroy the pupæ. I have not tried placing boards among the cabbages for this purpose; theoretically the plan appears to be a good one, but there may be practical reasons why it will not succeed, yet it is worthy of being thoroughly tested; but if left to hunt places in which to pupate, the gardener is likely to learn that he can find but few of them. Winter is the proper time for this work, and the fences, sheds and houses the places where they will be found.

As the eggs are scattered singly over the leaves, and are very minute, it will be exceedingly slow work to hunt them out and destroy them.

Killing the caterpillars is, after all, the most certain and effectual means of getting clear of them that can be adopted. It is true, it is somewhat laborious, and to some extent injures the cabbage in attempting to get at them, but Dr. Fitch's plan of using a pair of scissors will partially obviate this, and also somewhat lessen the labor. It is stated, that by placing a leaf on the top of the cabbage in the evening they will be attracted to it and can easily be gathered in the morning; I did not try this, but their known indisposition to leave the leaf on which they are at work would seem to render the advantage of this method doubtful; still it would be well for those who are troubled with them to try it.

During the past season a neighbor succeeded in procuring very fine heads notwithstanding the presence of the pest in large numbers. I was informed by him that his success was owing to the fact that, in the first place his ground was made as rich as possible; in the second place the plants were brought forward a little earlier than usual, some two or three weeks in advance of the usual time; and in the third place were pushed to heading by extra culture, and I believe by tying up the leaves in part. The variety used was the Flat Dutch.

I noticed in several cases that where the cabbages had been planted rather earlier than usual and the heads had formed, the result was favorable, for, notwithstanding all that has been said and written in reference to these worms boring into the heads, if they are firm and well formed they suffer comparatively little.

Certain varieties also appear to suffer less than others, but I am not prepared to state positively as to the names, and therefore can only call attention to the fact.

In concluding my remarks on this species, while I would urge further experiments with topical applications I would recommend to gardeners to rely chiefly on the following means:

Capturing the butterflies, especially the spring brood; killing the worms; earlier planting; selecting the firmest headed varieties; and giving the plants as vigorous growth as possible, by enriching the soil and thorough cultivation.

But the first remedy to be effectual depends upon concert of action.

Since the foregoing was written, I have ascertained that Prof. Riley has experimented thoroughly with the fungus or yeast remedy proposed by Dr. Hagen. He finds not only that it fails to produce an epidemical disease among the cabbage and other worms, but that individuals to which it is applied suffer no inconvenience whatever from it.

I understand from another gentleman with whom I became acquainted at the recent meeting of the Northern Illinois Horticultural Society, that he has seen pulverized cayenne pepper used, but it was of no

avail. Mr. Austin informs me that kerosene, as strong as the cabbage could bear, has been applied with no better effect.

A communication to the society just named, from an experienced gardener, states that during the past season he saved his cabbages by diluting carbolic acid with lime-water. The proportion in which the two are mixed will be given in a note as soon as the communication is published, being now in the hands of the printer. While I think it probable that success in this case was largely owing to careful cultivation and early-formed firm heads, yet this corresponds somewhat closely with the following experience related in the monthly reports of the National Agricultural Department for 1871. Mr. Quinn, the market-garden reporter for the New York Tribune, says that he made use of the following mixture: Twenty parts superphosphate made of slush acid, one of carbolic powder, and three of unslaked lime, mixed well together and dusted thoroughly into each head four times, at intervals of four days. This, he says, was effectual—the lime alone being of no value, and the carbolic powder alone destroying the cabbage, but to this agent he appears to ascribe the efficacy of the mixture.

Prof. J. H. Comstock, in an article to the *Prairie Farmer* of May 26, 1879, makes the following suggestions: "The wholesale destruction of the pupæ gathered from the boards placed among the cabbage does not seem to me to be the best thing to do. As many of them are infested with the parasite, *Pteromalus puparum*, by destroying the chrysalids the parasites are also destroyed. The importance of this point is well illustrated by the following experiment. In a collection of sixty chrysalids of the *Pieris rapæ* made at Ithica, N. Y.; fifty-seven were destroyed by this parasite before arriving at maturity."

"I should therefore recommend the collecting of the pupæ from the boards, but instead of destroying them place them in a box covered with a wire screen or a piece of mosquito netting. The chalcis flies are so minute that upon maturing and emerging from the chrysalids they can readily escape through the meshes of the netting and go on with their work of exterminating the mischievous larvæ; on the other hand the butterflies not injured by the parasite, being unable to escape from the box, can be killed or allowed to die in their prison. Another remedy I would suggest is the use of hot water, as this has been tried with success in many instances. Water heated to 140 degrees fahrenheit will not injure the plant and will destroy the worm very effectually. It should be applied by a watering pot so that the plant may be thoroughly drenched in all the infested parts."

The following statement from another correspondent is found in the same paper: "It is said that cayenne pepper sprinkled over cabbage plants is a sure preventive of worms, destroying them and not injuring the plants. It would probably be more effectual if a light tincture were made and the plants lightly watered with it. My experience with the green cabbage worm was of benefit to my neighbors as well as myself. On their first appearance there were hundreds. I dusted black pepper over them before the dew was off. After the second application only twelve worms remained on 130 heads of cabbage. I sent them to bug heaven by rubbing turpentine on their backs with a feather and now our patch is entirely unmolested."

Mr. Saunders remarks (*Can. Ent. Oct. 1878*) that strong decoctions of cayenne pepper and smartweed have been highly recommended.

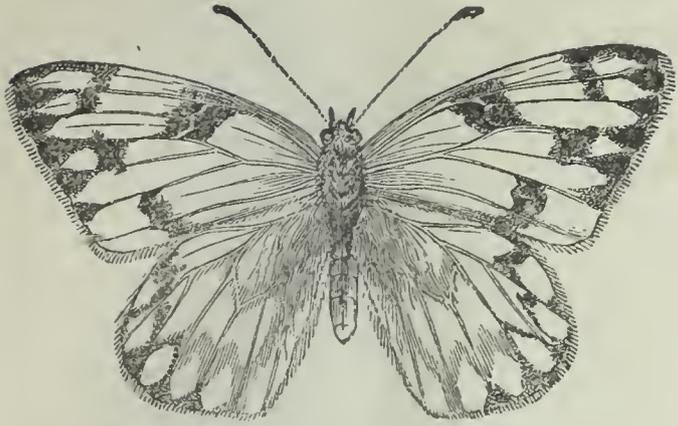
THE SOUTHERN CABBAGE-BUTTERFLY.—*Pieris protodice*. Bd. Lec.

FIG. 5.—Southern Cabbage Butterfly.

each other and extending the whole length of the body; each of these lines has two blue dots in them on each segment; the under side a paler green, flecked with dark dots; head usually the same color as the body. Rather largest in the middle and tapering slightly toward each end; the sutures between the segments more distinctly marked than in the other species. This; as well as the larvæ of the other species, has sixteen legs, six near the head, eight ventral, and two on the

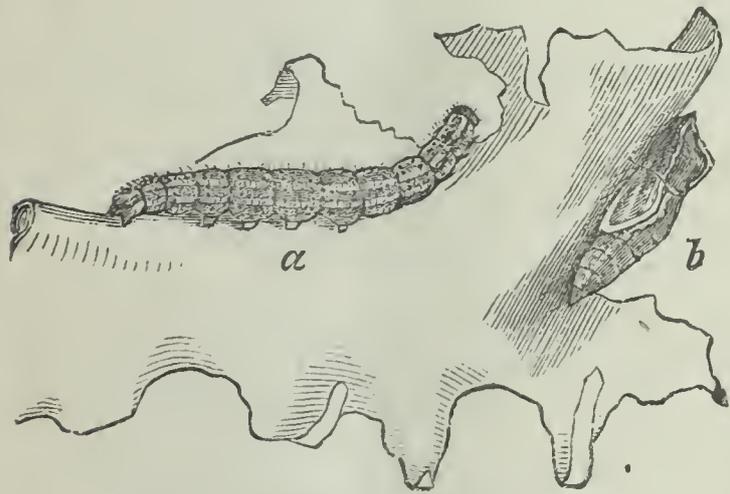


FIG. 6--a, Larva. b, Chrysalis.

This and the following species are inserted here only for the purpose of enabling those who receive this but are not in possession of my former reports to distinguish the species of this genus, which are found occasionally infesting cabbage in Illinois.

The caterpillar is of a greenish blue color, with four longitudinal yellow stripes equally distant from each other and extending the whole length of the body; each of these lines has two blue dots in them on each segment; the under side a paler green, flecked with dark dots; head usually the same color as the body. Rather largest in the middle and tapering slightly toward each end; the sutures between the segments more distinctly marked than in the other species. This; as well as the larvæ of the other species, has sixteen legs, six near the head, eight ventral, and two on the posterior segment. Length, when full grown, about one inch and one-eighth. When newly hatched they are of a uniform orange color, with a black head, but become a dull brown before the first moult.

The chrysalis differs but slightly from that of *P. rapæ*; it is generally a light blueish gray, more or less speckled with black, the ridges edged with buff or reddish. The anterior point is usually less acute than in *P. rapæ*.

The figures of the butterflies given here will sufficiently distinguish this from the other species. The ground color is a dull white without any tinge of yellow; the female, which is the larger of the two sexes, (Fig. 5) has the outer margin of the fore wings marked with a row of triangular black spots; there are also four trapezoidal black spots placed as shown in the figure. In the male, the black markings are similar in form and position so far as they appear, but generally the marginal line and posterior spot are wanting or but faintly represented; and the hind wings are without the gray shading so distinct in the female. Expansion of the wings varies from one and three-fourths to two and one-half inches.

Found throughout the State and very common, but only occasionally seriously injurious to cabbages.

THE POTHERB BUTTERFLY. *Pieris oleracea*. Boisd.

This species is easily distinguished from the others here mentioned, the butterfly being entirely white or yellowish white, without spots; the wings are, as in the others, somewhat dusky at the base but there are no black spots on either the anterior or posterior wings; they are more or less tinted with yellowish or straw color, especially on the underside.

The caterpillar is of a dark, velvety green color, somewhat uniform in size throughout its length, without any distinct stripes; segments not very distinctly marked; length when fully grown one inch and a quarter to one inch and a half.

The chrysalis is pale green or white, finely dotted with black; the anterior point is generally rather more prolonged than in either of the other species.

This species is found only in northern latitudes, its range in this State not extending even to the central portion, so far as I am aware.

NORTH AMERICAN SPECIES OF PIERIS.

I have concluded to give here, for the benefit of the readers of this report, a short account of the North American species of this genus, with some remarks in reference to the habits and geographical distribution of the species.

As has been truly remarked by Rev. J. G. Wood (*Insects at Home*), common as these butterflies are, they have raised quite a controversy among entomologists, and have been shifted backward and forward until it is scarcely possible to reconcile the conflicting views. I shall therefore treat the genus as employed by Boisduval and as Dr. Morris defines it in his synopsis, with such restrictions as appear to be required by the most recent authorities.

In this sense it may be distinguished from the closely allied genera by the antennæ not being truncated and having the club ovoid and compressed; the palpi less compressed, with the last joint always nearly as long as the preceding; by the less robust body, and the thinner wings, which, at least so far as our species are concerned, have the ground color white or at most with but a faint tinge of yellow, and often more or less spotted with black.

They never have those central silvery or ferruginous spots which are always present on the underside of the wings of the *Colias* or sulphur butterflies.

In order to illustrate the difficulty economic entomologists' experience in attempting to present to non-scientific readers, in a work of this

kind, general conclusions, I will give here the lists of the North American species of *Pieris* as given by three authors, Dr. Morris, Mr. Edwards and Mr. Strecker. The latter will, as a matter of course, include species described since Dr. Morris' Synopsis was published, but as will be perceived by the lists which show the names considered as synonyms, which are unnumbered and belong to the numbered name under which they are respectively placed, there is little unanimity in reference to what are true species.

MORRIS.	EDWARDS.	STRECKER.
1. <i>Monusta</i> . Hub. <i>Orseis</i> . Godt. <i>Cleomes</i> . Boisd.	1. <i>Oleracea</i> . Boisd. <i>Casta</i> . Kirb. <i>Cruciferarum</i> . Boisd.	1. <i>Napi</i> . Linn. <i>Venosa</i> . Scudd. <i>Nasturtii</i> . Boisd.
2. <i>Protodice</i> . Boisd.	2. <i>Frigida</i> . Scudd.	<i>Pallida</i> . Scudd.
3. <i>Sisymbrii</i> . Boisd.	3. <i>Castoria</i> . Reak.	<i>Iberidis</i> . Boisd.
4. <i>Leucodice</i> . Eversm.	<i>Resedæ</i> . Boisd.	<i>Castoria</i> . Reak.
5. <i>Autodice</i> . Hub.	4. <i>Rapæ</i> . Linn.	<i>Resedæ</i> . Boisd.
6. <i>Oleracea</i> . Harr.	5. <i>Yreka</i> . Reak.	<i>Oleracea</i> . Harr.
7. <i>Casta</i> . Kirb. <i>Cruciferarum</i> . Boisd.	6. <i>Venosa</i> . Scudd. <i>Nasturtii</i> . Boisd.	<i>Cruciferarum</i> . Boisd.
8. <i>Menapia</i> . Feld.	7. <i>Marginalis</i> . Scudd.	<i>Casta</i> . Kirb.
9. <i>Frigida</i> . Scudd.	8. <i>Pallida</i> . Scudd.	<i>Frigida</i> . Scudd.
10. <i>Venosa</i> . Scudd.	<i>Iberidis</i> . Boisd.	<i>Hulda</i> . Edw.
11. <i>Marginalis</i> . Scudd.	9. <i>Protodice</i> . Boisd.	2. <i>Virginensis</i> . Edw.
12. <i>Pallida</i> . Scudd.	10. <i>Occidentalis</i> . Reak.	3. <i>Rapæ</i> . Linn.
13. <i>Tau</i> . Scudd.	11. <i>Sisymbrii</i> . Boisd.	<i>Marginalis</i> . Scudd.
	12. <i>Vernalis</i> . Edw.	<i>Yreka</i> . Reak.
	13. <i>Beckerii</i> . Edw.	<i>Novanglicæ</i> . Scudd.
	14. <i>Monuste</i> . Linn. <i>Cleomes</i> . Boisd. <i>Orseis</i> . Godt.	4. <i>Monuste</i> . Linn. <i>Cleomes</i> . Boisd. <i>Orseis</i> . Godt. <i>Albusta</i> . Sept. <i>Phileta</i> . Fabr. <i>Suasa</i> . Boisd.
		5. <i>Protodice</i> . Boisd. <i>Vernalis</i> . Edw.
		6. <i>Occidentalis</i> . Reak.
		7. <i>Sisymbrii</i> . Boisd.
		8. <i>Chloridice</i> . Hub. <i>Beckerii</i> . Edw.
		9. <i>Calyce</i> . Edw.

In the midst of this confusion it is difficult to come to a satisfactory conclusion as to which are true species and which mere varieties unless we had specimens of each before us, and even then we should find ourselves still involved in doubt. I shall therefore undertake nothing more than to present some remarks that may be of some value especially to young Entomologists who are studying our butterflies, and which will give a general idea of the characteristics and distribution of the species.

First we may lessen the list by eliminating those in reference to which there appears to be now a general agreement that they are but varieties or foreign.

Orseis and *Cleomes* are but synonyms of *Monuste*; *Leucodice* and *Autodice* of Morris' list are foreign and not represented in this country; *Casta* and *Cruciferarum* are synonyms or varieties of *Oleracea*; *Menapia* does not belong to this genus and *Tau* is but a synonym or at most but a variety of that species, and hence does not belong to *Pieris*. The following may also be omitted as confessedly synonyms, varieties or unknown in this country; *Resedæ*, *Nasturtii*, *Iberidis*, *Hulda*, *Novanglicæ*, *Albusta*, *Phileta*, and *Suasa*.

Monuste is a tropical species found in the extreme southern states, West Indies and southward to Brazil.

Protodice, which has already been described, according to Mr. Strecker, is found throughout the United States from the Atlantic to the Pacific and from the Gulf to British America. *Vernalis*, Edw., as shown by the observations of Mr. Bean, and as acknowledged by Mr. Edwards, is but a variety of this species. It is rather smaller than the typical form, and has the underside of the veins broadly bordered by greenish-gray or pale olive-brown. It appears early in the spring and late in the fall thus indicating that it is produced by the colder weather of these seasons.

According to Mr. Scudder, *Protodice* is the American representative of the European *Daphidice*, the Alpine *Callidice*, the Siberian *Leucodice*, the South American *Autodice*, the Arabian *Glaucanome* and the South African *Nellica*.

Sisymbrii, Boisd., is found in California and appears to be confined to the Pacific Slope and is very closely allied to *P. napi*, Linn. It is possibly a variety of *Oleracea*.

Napi, Linn., has been introduced by Mr. Strecker into the list of North American species, under which he has placed as varieties *Oleracea* and several other species. Without attempting to discuss the propriety of this course, we prefer to follow the generally accepted opinion, omitting *Napi* from our list and considering *Oleracea* as a distinct species.

Oleracea, Harr., is, as heretofore stated, a northern species extending south as far as the Middle States, even to Virginia, northward to Slave lake, in British America, and westward at least to Colorado and probably the Pacific slope.

Frigida, Scudd., which is found in Labrador, is beyond any reasonable doubt a variety of this species. *Pallida*, as Strecker indicates, is in all probability another variety, which represents the species on the western coast. *Iberidis*, Boisd., *Castoria*, Reak., and *Resedae*, Boisd., are doubtless, as Mr. Strecker considers them, synonyms of *Pallida*, all being found on the Pacific slope.

Venosa, Scudd., appears to be the American representative of the European *Napi*, and Mr. Strecker has probably introduced the latter in our list because he considers *Venosa* as belonging to it. But it is perhaps best to follow Messrs. Scudder and Edwards in this case, and consider it as a distinct species although very doubtful. I would not be surprised if after all it should ultimately prove to be but a variety of *Oleracea*. *Nasturtii*, Boisd., appears to be another name of the same species; and *Marginalis*, Scudd., but a variety scarcely distinguishable by the description.

Beckerii, Edw., which is found in Nevada and Utah, is considered by Mr. Edwards as a distinct species; but Mr. Strecker gives it in his catalogue as a synonym of the European, or rather, Northern Asiatic, *Chloridice*, Hub. Judging from the beautiful figures of it in Mr. Edwards' work, I should say it was but a western variety of *Protodice*, produced by the climatic conditions of the section in which it is found.

Occidentalis, Reak., which is considered by both Edwards and Strecker as a good species, is closely allied to *Protodice* and may ultimately be found to be only a western variety of that wide spread and somewhat variable species. It has been found only in Colorado and Nevada, and hence the name *Occidentalis* or Western.

Virginiensis, Edw., is also admitted into the lists of some authorities as a good species, but it is an unspotted insect, so closely allied to *Oleracea* that there would appear to be no substantial grounds for considering it as distinct. The only difference noticeable, is a slight grayish brown shade on the basal portion of the wings above. It has been found in Virginia and Mr. Saunders states that he has also found it in Canada. The larva, in color and markings as well as habit, agrees exactly with that of *Oleracea*, hence we think it safe to consider it but as a variety of that species.

Yreka, Reak., is certainly very closely allied to *Rapæ*, and hence Mr. Strecker, who has the type specimens in his possession, appears to be fully justified in connecting it with that species. As *Rapæ* is found in Siberia and a large portion of Northern Asia, it would be nothing strange to find it in California, the locality from which Mr. Reakirt's specimens were obtained.

Novangliæ, Scudd., is confessedly but a yellow variety of *Rapæ*.

Calyce, Edw., appears to be recognized as a true species. It is found in Nevada and California, and is closely allied to *Sisymbrii*.

For our present purpose—but without any attempt to decide critically in reference to what are true species, as this must be decided by those who make the butterflies a special study—we will adopt the following arrangement:

- | | |
|----------------------|------------------------|
| 1. OLERACEA. Harr. | Nasturtii. Boisd. |
| Pallida. Scudd. | Marginalis. Scudd. |
| Iberidæ. Boisd. | 4. MONUSTE. Hub. |
| Castoria. Reak. | Hippomonuste. Hub. |
| Resedæ. Boisd. | Cleomes. Boisd. |
| Cruciferarum. Boisd. | Orseis. Gott. |
| Casta. Kirb. | Albusta. Sepp. |
| Frigida. Scudd. | Phileta. Fabr. |
| Hulda. Edw. | Suasa. Boisd. |
| Borealis. Grote. | 5. PROTODICE. Boisd. |
| Virginiensis. Edw. | Vernalis. Edw. |
| 2. RAPÆ. Linn. | Beckerii. Edw. |
| Yreka. Reak. | 6. OCCIDENTALIS. Reak. |
| Novangliæ. Scudd. | 7. SISYMBRII. Boisd. |
| 3. VENOSA. Scudd. | 8. CALYCE. Edw. |

I give here descriptions of some of the most prominent species and varieties:

1. *P. OLERACEA*.

In addition to what has already been given, I should state that the body is black; antennæ blackish, annulated with white; ochreous at the end of the club.

a. *Pallida*.—Above, very pale-yellowish, nearly white; base of both wings and basal half of costal border of primaries dotted with grayish scales; whole costal edge of primaries black; the male has, in addition a band of grayish scales on the posterior border of primaries, as in the male of *P. venosa*, turned abruptly towards, and sometimes interrupted at the angle, extending to the third inferior nervules; and in the middle of the space between first and second inferior nervules, as in both sexes of *P. venosa*, a cluster of grayish scales.

Beneath, secondaries and apex of primaries yellowish, with sometimes a few indistinct grayish scales scattered along the nervures, otherwise quite immaculate.

Body, above black, with scattered yellowish hairs, beneath yellow; antennæ as in *P. venosa*. The wings expand two inches.

(Scudder.)

- b. *Castoria*.—Size and form of *Pieris oleracea*; *Male*, upper side pure white, inner half of costa of primaries, and base of both wings, strewn with a few dark atoms; a rounded black spot in the medio-superior interspace of the fore wings, situate as in the preceding species; no other markings; fringes white, expanse 2 to 2.12 inches. Underneath immaculate white; a faint yellowish tinge on the apex of the primaries, and along the costa of the secondaries. Body black, with whitish hairs below; antennæ black, with incomplete white annulations interrupted above. Club yellowish, or yellowish brown at tip. (Reakirt.)
- c. *Casta*.—Antennæ black, annulated with white; wings white; primaries at the anterior margin, sprinkled with blackish; secondaries, underneath, with a few scattered black scales accompanying the nervures; wings rounded and very entire. (Kirby.)
- d. *Frigida*.—The shape of the secondaries of the male *frigida* is as in the female of *oleracea*, those of *frigida* being proportionally narrower across the hind margin, and broader across a line parallel to it, near the base of wing, than in the same sex in *oleracea*; or in other words, the secondaries of *frigida* are relatively more quadrate, and those of *oleracea* more triangular; the outer half of the costal border of the secondaries is slightly more docked in *frigida* than in *oleracea*; the dark narrow line which follows the costal border of the primaries extends around over rather more than half the outer border of the wing, while in *oleracea* it seldom extends beyond the tip, and very rarely half way round the outer border; the nervures on the under surface are more heavily marked than in the darkest individuals of *oleracea*, though the markings are in the same locality, such as the outer and uppermost nervules of the primaries, the median nervure, the nervures of the secondaries, except the discal, the inner margin next the base, and a band crossing the cell, which is the extension of the third superior nervule; the markings of the primaries are heaviest towards the outer border, those of the secondaries away from it; the costal border of the secondaries at base is slightly tinged with saffron; the color of the under surface of the wings is slightly dirty white, tinted with very pale greenish yellow, especially noticeable on secondaries and upper half of primaries; when any color is present on the primaries of *oleracea* it is confined to the tip; it differs further from *oleracea* in having the black scales at base of both wings above more profuse and widely spread, frequently bordering the nervures quite broadly; indeed grayish scales are more or less scattered over the whole of the upper surface, giving the insect a grim appearance, increased rather than diminished by the slightest possible yellowish tint. (Scudder.)
- e. *Hulda*.—A variety with the veins of the under surface so heavily accompanied by blackish-green scales that but little of the pale-yellow ground color of the wing is visible.
- f. *Borealis*.—This is given as a mere variety by Mr. Grote. The markings on the veins are much darker and broader than usual, especially beneath. The species thus resembles *frigida*, but the elongated form of the hind wings peculiar to *frigida* is totally wanting. This is a renewed example of the interesting fact that

white butterflies assume darker colors when inhabiting elevated localities or higher latitudes. (Grote.)

g. Virginiensis.—Male expands 1.7 inch.

Upper side white, less pure than *Oleracea* and much obscured by grey brown scales, which are scattered over the whole surface, but are dense on apex, costa and basal half of primaries, at the base and along the subcostal and median nervues of secondaries; a grey patch also on costa of secondaries.

Under side white, the nervures all bordered with grey brown, most conspicuously on sub-median of both wings and the branches of this nervure on secondaries; shoulder pale orange.

Body above blue-grey, beneath white; palpi white, tipped with grey; antennæ blackish above, finely annulated with white below; club black, tipped with yellowish.

Female, expands 1.9 inch.

Similar to male, the surface usually still more obscured.

This species is allied to *Oleracea*, from which it may be readily distinguished by the shape of its wings, which are longer and narrower; by their texture, which is more delicate, and by the constant presence of grey scales over the surface. In the Kanawha district it replaces *Oleracea* which is yet unknown there. It is not uncommon in the month of May, frequenting open woods rather than gardens, and in this respect differing in habit from the allied species. I have never met with it later than June, though *Oleracea* in the northern States, is most abundant after that month and continues breeding till the early autumn frosts. (Edwards.)

2. P. RAPÆ.

This species has been already fully described, the following are descriptions of the varieties.

a. Yreka.—Size and form of *Pieris rapæ*; *Male*, upper side white, base sprinkled with black atoms extending along the costa of the primaries as far as the end of the cell; a narrow, black, terminal line at the apex, and below this, a few scattered black specks; a rounded black spot on the medio-superior interspace, midway between the cell and the margin. Secondaries with a small black spot on the costa, at two-thirds its length from the base; fringes white, expanse 1.88 inches.

Underneath, the apex of the primaries is pale ochrey-yellowish; an additional small black spot is in the medio-inferior interspace, otherwise as on the upper surface. Secondaries pale orchrey-yellowish, thickly strewn with grayish or greenish-brown atoms, especially condensed towards the base; costa yellowish-orange.

Body above black, with scattered whitish hairs; below white. Antennæ black, ringed with white; club tipped with white.

Female differs in having a large triangular apical patch, brownish-black, of which the lower portion is densest, upon the primaries, and in the enlargement of their central black spot, and also in that of the costal one upon the secondaries.

Below, the primaries, as in the *male*, the hind wings much more yellowish. (Reakirt.)

b. *Novanglicæ*.—This variety differs remarkably from the normal forms of *Rapæ* in the color of both surfaces of the wings; these, if we except the dusky markings, are of a sulphur-yellow, approaching in depth of color the wings of the *Eurema Lisa*.

3. P. VENOSA.

Above, white tinted with very pale greenish-yellow; base of all the wings black, and costal border of primaries with a black band, extending about half its length; extremities of upper nervules of primaries broadly margined with black scales, with a spot of the same color in the middle of the space between first and second inferior nervules; a black dot at the tips of the nervules of secondaries. The female differs from the male in having nearly all the nervures on upper side of primaries somewhat bordered with grayish scales, and the extremities of the lower nervules almost equally with the upper; but most characteristically by the presence of a band of grayish scales along the posterior border of primaries, which is bent abruptly upwards in the direction of the spot in the space between first and second inferior nervules, and continues to third inferior nervule, sometimes interrupted at the angle.

Beneath, as in the darker forms of *P. oleracea*, with the ground color slightly more highly colored than the upper surface; the nervures of the secondaries being heavily, and those of the primaries more narrowly bordered with grayish scales, with a saffron-colored spot at the base of costa of secondaries. Antennæ black, with incomplete white annulations interrupted above; tip of club yellowish; body black, with whitish hairs beneath; the wings expand from 1.5 to 2 inches. (Scudder.)

a. *Marginalis*.—This species is most closely allied to the preceding, (*P. venosa*.) The ground color is as in *venosa*, but almost devoid of markings; base of all the wings black; costal border of primaries with a narrow black band, extending about half its length; a few grayish scales at the tip of wings; outer edge of primaries and posterior edge of secondaries with a very fine black line, slightly swollen at the tips of the nervures; fringe white; beneath, as in *P. venosa*, with the secondaries and apex of primaries more yellowish; males and females alike in their markings.

Body black with some white hairs above, and a considerable number of yellowish-white ones beneath; antennæ as in *P. venosa*: The wings expand two inches.

(Scudder.)

4. *Monuste*—*male*.—Upper surface of primaries white with a black border, wider at the summit, serrated within. Upper surface of secondaries entirely white in the males. Under surface of primaries white, with the border pale brown or yellow ochre.

Under surface of secondaries yellow ochrey, more or less pale, with the border pale brown, and a saffron spot at the base.

The female has an arcuated black line on the middle of the primaries, and a marginal series of black triangular spots in the secondaries.

Body white; thorax obscure; shoulders grayish; neck ferruginous. Antennæ black, annulated with white; tip of the club greenish. Expands two to three inches. (Boisduval.)

a. *Phileta*.—This is a smoky or dark form of the female.

5. P. PROTODICE:

This species has already been sufficiently described, and as heretofore stated, is the most common native species met with in Illinois.

a. *Vernalis*.—Male. Expands 1.7 inches. Upper side white; primaries have small black serrated spots at the extremities of the apical nervures, preceded by an imperfect abbreviated row of small black patches; a black bar on the arc. Secondaries more delicate, showing the markings of underside.

Underside of primaries white; the spots reproduced, but pale colored and dilated, those at the apex tinged with greenish gray; an additional black patch on sub-median interspace, sometimes wanting. Secondaries have all the nervures broadly edged with greenish gray so that none of the white surface appears, except in narrow stripes in the cell and interspaces; near hind margin a band formed by gray serrations connecting the nervules. Body covered above with blue gray hairs; beneath, thorax grey white, abdomen yellow; palpi yellowish; antennæ black above, annulated below with white; club black tipped with ferruginous.

Female. Expands 1.8 inches.

Color less pure, similarly marked, the spots larger, the discal bar conspicuous; secondaries show clusters of grey scales on costa and at outer angle and in the interspaces on the margin; underside, as in the male. (Edwards.)

b. *Beckerii*.—Primaries produced apically, slightly excavated on costal and hind margins.

Male. Expands 2 inches.

Upper side pure white, the texture of secondaries slighter than that of primaries, discovering the spots of under surface; base of wings not powdered with black as in allied species; primaries have the apical half of the hind margin bordered by small black patches or clusters of scales diminishing in size to middle of margin; anterior to these two similar sub-apical patches and a third in upper median interspace; on the arc a dense black sub-rectangular spot not reaching the costa) with central white streak. Secondaries immaculate. Fringes white except against the apical spots, there black.

Underside white; the nervules at apex and on upper hind margin bordered by black scales and suffused with greenish yellow; the spot on interspace black, and as on upperside; cellular spot enlarged, its base broadened and posterior edge excavated.

Secondaries have all the nervures and their branches yellow; those terminating on hind margin edged by broad bands of yellow green reaching from middle of disk and connected anteriorly; three large spots of same color about the cell, two being at the outer angles, and one above and reaching the costa; another large triangular sub-apical spot on costa; the nervures at base also banded with

green; all these bands and spots slightly sprinkled with black scales. Body above covered with grey hairs; beneath, abdomen yellowish, thorax white; legs white; palpi white, gray on upper side and at tip; antennæ white above and at base below, beyond brown; club black, nearly covered with rows of white scales; tip pale fulvous.

Female.—Expands 2 inches.

Primaries less produced and broader than in the male, same shade of color; the marginal spots enlarged and extended to second branch of median; in addition to the three submarginal spots, which are also enlarged, is another in submedian interspace and a streak below this along inner margin; the cellular spot much enlarged, rhomboidal, with slight central streak; secondaries have a patch on costa and four on the marginal nervules commencing at and posterior to subcosta, also an interrupted sub-marginal stripe opposite cell, posteriorly indistinct; underside as in male except that a round black spot appears in submedian interspace on primaries.

(Edwards.)

6. *P. OCCIDENTALIS*.

This species, as before stated, is closely allied to *Protodice* and *Beckerii*, but according to Edwards is abundantly distinct from them.

7. *P. SISYMBRII*:

Upper side white; primaries with a subcostal spot; a transverse, interrupted ray and some longitudinal streaks at the end of the nerves, blackish brown; secondaries without spots. Under side of primaries similar to the upper, except the streaks, which are powdered with greenish brown. Underside of secondaries white, with the nerves widely edged with greenish brown, dilated towards the marginal edge and nearly united between this edge and the cellule by a transverse ray; obsolete, more or less interrupted. (Boisduval.)

In reference to the habits and to the larvae of most of these species and varieties, except the three most noted, *Rapæ*, *Oleracea* and *Protodice*, but little appears to be known.

The larvæ of *Monuste* is violet with yellow longitudinal lines; the head, feet, and under surface of the body yellow or greenish-yellow. It feeds on a species of *Spider Flower*,—(*Cleome pentaphylla*) which belongs to a group of plants much resembling the crucifera, though more acrid in their properties.

The specimens upon which Mr. Edwards founded his *Beckerii* were taken at Virginia City, Nevada, in April, on flowers of Brassica.

The habits of *Virginiensis* are thus described by Mr. Edwards. "In the Kanawha district it replaces *Oleracea*, which is yet unknown there. It is not uncommon in the month of May, frequenting open woods rather than gardens, and in this respect differing in habit from the allied species. I have never met with it later than June, though *Oleracea*, in the northern states, is most abundant after that month and continues breeding till the early autumn frosts." He states that he has received specimens from Mr. Saunders, of London, Canada, who informed him it was a rare insect there.

"The larvæ of this group of *Pieris* feed upon garden vegetables, Brassica, Raphanus, Nasturtium, and allied plants in a wild state, and are sometimes exceedingly destructive. The female butterfly deposits great numbers of long slender pointed eggs upon the under-

side of the leaves, often a score or more upon a single leaf. These eggs are greenish white in color, and stand at right angles to the surface. To an inexperienced person they might seem to be eggs of some fly, or the result of a disease of the leaf itself, but they would not be suspected to be the eggs of any butterfly.

"In four or five days the young larvæ emerge, one tenth of an inch in length, green in color, requiring a keen sight to discover them. At once they attack the leaf eating a small hole, and to the margin of this they return when disposed to feed, till all the surrounding parts are eaten away. The large leaves of horse-radish may be entirely consumed in this way leaving but the skeleton untouched.

"When at rest the larvæ lie extended upon the surface of the leaf, generally along one of the ribs or in a depression, and as they retain their green color to maturity they are effectually screened from notice. When mature they are about one inch in length, cylindrical, covered with fine white papillæ from each of which is emitted a single short hair. The chrysalids are brownish white marked anteriorly by a few points and short lines of black, and are distinguishable from those of any other genus by angular ridges on the back of the wing covers and head. They may be attached to fences and buildings near the food plant or to the plants themselves. This description will apply either to *Oleracea* or *Rapæ* which, in both larval and chrysalis states are extremely alike. And doubtless will be found to apply as well to the same stages of *Virginensis*."

The larvæ of *Napi* and *Oleracea* and of all their varieties, so far as known, feed on the leaves of cabbage, turnips, radish; mustard and other cruciferous plants. Those of the *Rapæ* and its varieties feed on cabbage, turnips, horse-radish, mignonnette and some other plants.

A few words in reference to the characteristics and habits of some of the more noted foreign species may be of some advantage in this connection.

P. BRASSICÆ, Linn.

Which has so long been noted in Europe as the foe of the cabbage is thus described:

Both sexes have the upper surface of all the wings white, with the tips of the anterior wings above, black, the patch on its inner edge being indented, the points of the indentations following the direction of the nervures, and the extreme tip being slightly irrorated with white, with the cilia waved with black and yellowish; the female has also two roundish transverse spots on the disc, and an elongate triangular one on the inner margin of the wing; the costa and base of the anterior wings are irrorated with dusky, and sometimes tinged with yellowish; and the posterior wings have a black costal spot; the under surface of the anterior wings in both sexes is similar; the tips being yellowish, the base slightly irrotated with dusky, and two transverse spots adorning the disc: the posterior wings are pale yellowish beneath, with a very obsolete costal spot, and are rather thickly sprinkled with dusky, especially in the female; the body and antennæ are black above, and white beneath, the latter having an interrupted brown line from the base to the capitulum, which gives them the appearance of being annulated, the capitulum itself is yellowish at the tip.

(Stephens.)

The caterpillar is greenish, with three yellow longitudinal lines, one along the back, the others on the sides; between these are several tubercular black spots, each bearing a pale hair; the tail is black; when full grown it is about an inch and a half long. The chrysalis is greenish gray spotted with black, with some yellowish stripes. In England this species appears about the middle or first of May, and about the end of the month deposits its eggs in clusters usually on the underside of cabbage leaves. The caterpillars soon hatch and continue to feed together till about the end of June. This summer brood remains in the pupa state, as a general rule, about sixteen days. Mr. Stephens, from whom I chiefly take these statements, remarks that during one season, when the species was very abundant the pupation of one brood was completed in seven days.

P. NAPI, Linn.

As Mr. Strecker has introduced this species into the North American list I give a description of it and also of some of its European varieties, which were for a time supposed to be distinct, as a means of comparison.

Wings above, white, with the tip of the anterior dusky; the male with a black spot between the middle and hinder margin of the anterior wings, the under surface of these wings has the nervures dusky, with the tips pale yellow, and two dusky spots towards the hinder margin; the posterior wings beneath, are pale sulphur yellow, with the nervures much dilated and dusky greenish; the nervures on the costal edge of the discoidal cell with a clear yellow dash. The female has the anterior wings more rounded than the male, with two large black spots placed transversely and an obscure claviform dash towards the thinner edge; both sexes have a black costal spot on the posterior wings above; the body black with its under part white; the antennæ white, annulated with black.

Var. *a*—with the base of all the wings in both sexes deep black.

Var. *b*—Male with the anterior wings immaculate above, with one indistinct spot beneath; the base of all the wings above, clear black.

Var. *c*—Both sexes with the nervures of the posterior wings dilated at the base beneath.

Var. *d*—Female with the wings yellowish above.

Var. *e*—Dilated nervures of the posterior wings beneath, dusky in both sexes.

The caterpillar is greenish-brown, clearer on the sides, with the stigmata yellowish; it is covered with white tubercles with black tips bearing very delicate hairs. It feeds on the *Brassica napus* and similar plants, like its congeners. The chrysalis is greenish-yellow, spotted on the head and back; with the anterior edge of the wing-cases strongly spined.

Var. *Napus*—Like its congeners, this species varies considerably; the male has the upper surface of the wings milk-white, with the tip, a spot, and two or three triangular dashes on the hinder margin of the anterior, black; beneath, the latter have slightly dilated greenish nervures, with two cinereous spots placed transversely, and a yellowish tip; the posterior wings are pale yellowish with a deeper costal streak; the

basal nervures above dilated and greenish. The female has the tip of the anterior wings, and three spots, one of which is sub-triangular, and placed on the thinner edge of the wings, black or dusky, and the posterior wings are clearer yellow. The nervures on the under surface of the posterior wings, are more or less dilated in different specimens.

Var. *a*—Female without the transverse cinereous spots beneath.

THE CABBAGE PIONEA.—*Pionea rimosalis*, Guen.

The advent of the European Cabbage butterfly in the immense numbers seen the past summer (1879) was sufficient to discourage our gardeners in their efforts to raise the valuable esculent which is the especial object of the attacks of the larvæ. I had battled with these caterpillars for a month or so, devoting a large share of my cabbages to their use for the purpose of experimenting with them and studying their habits, the results of which are given in the preceding pages.

When cold weather should have set in according to the usual custom of this climate, I thought I had succeeded in saving the portion I had undertaken to save,—but a warm spell coming on, and having neglected them during a few days absence from home I was surprised on going into the garden after my return to find the outer leaves of those which were comparatively uninjured when last seen, thoroughly riddled with elongate, oval holes. This rather unusual appearance soon attracted my attention by its singular uniformity,—I had noticed before this, now and then a leaf riddled in this way by the larvæ of *Pieris rapæ*, but the uniformity in the shape of the holes and the extent of the work, appeared to me to be something different from what I had seen before.

Immediately on my return home, my assistant, Miss Middleton, had remarked to me that another worm was at work on the cabbage, and doing more mischief than the larvæ of *P. rapæ*. I paid but little attention to the remark at the time, supposing it to be the larvæ of our native species; *Pieris protodice*, but I was soon undeceived by an examination. To my dismay I found a new and hitherto unknown enemy of the cabbage, a new cabbage worm; not one here and another there at rare intervals, but more numerous, if possible than the green larvæ of the cabbage-butterfly, and working away with all the energy of which their caterpillar nature seemed possessed. It was too late now to save my esculents, but I had the mournful satisfaction of knowing that I could be the first to inform the world of this new cabbage pest. I should have experienced a far greater satisfaction had I been able to make known to our gardeners and farmers the fact that some hitherto destructive insect had, like the Dodo, become extinct.

Fortunately Miss Middleton had some in the breeding cases already in the chrysalis state from which soon afterwards the moths issued, thus affording an opportunity of determining positively the species.

Feeling an uncertainty in reference to the determination of the species, as I had nothing in my cabinet like it with which to compare it, and finding no notice of a similar species injuring cabbages in this country, I forwarded a specimen to Dr. Grote for examination; he kindly informed me that it was the *Orobena rimosalis*, Guen. I have adopted the older and more comprehensive generic name as one more easily referred to than the more restricted genus in which Dr. Grote places it, although the latter is the one in which it belongs as the genera are now restricted.

The eggs were not observed, hence it is impossible to say any thing positive in reference to them; as a matter of course they are deposited on the plants on which the worms are found feeding; from the fact that the worms when quite young were associated in considerable numbers on the same cabbage and often close together, I presume the female deposits a number of eggs at one point, probably near the base of the outer leaves and most likely on the inside.

The caterpillar, when full grown, is six or seven tenths of an inch long; with sixteen legs; is slender and slightly flattened. Head, dull greenish-yellow, with a few scattering hairs on it; mouth parts dusky. The dorsal portion of the body, down to the breathing pores, purplish brown, with two or three white, transverse lines on each segment, but these extend laterally only to the margin of the sides and not to the lower margin of the brown area; a narrow pale yellowish line along the region of the breathing pores; underside pale green. On the sides, along the lower margin of the brown color, there is a minute, shining, black tubercle on the middle of each segment; each supporting a stiff black hair; in the yellow line there is a black dot at each breathing pore. The black tubercle of the first segment is on the margin of the dorsal shield; and those on the second and third segments are drawn up toward the back so that they are not in a line with those on the remaining segments. On each side of the back, just within the margin enclosed by the white transverse lines, on the middle of each segment, is a small white tubercle surrounded by a black ring; each supporting a hair. Between this upper row of white tubercles, or small pimples, and the lateral row of black ones, is another row of small black dots or pimples, one on each constriction between the segments, back of the third. The dorsal shield of the first segment, is pale glassy green, clouded especially on the sides with fuscous.

This description was taken from living specimens taken from cabbages, November 21st. The tubercles mentioned in the foregoing description are to be understood as minute pimples or raised points.

I failed to find any pupæ in the garden, and hence cannot state positively in reference to the places selected in which to undergo their transformations. Those in the breeding cages, formed cocoons on the surface of the dirt, covering them externally with a layer of sand. They are usually exactly oval in form and cylindrical, the length varying but slightly from half to six-tenths of an inch. The cocoon proper or silken portion is very thin, formed apparently only to hold the particles of sand with which it is thickly surrounded. The pupa is of a glossy brownish color. The pupa state of the summer brood (or broods) lasts about seven or eight days; the record of those reared being as follows (twenty or more specimens); went into

the pupa state September 12th, 13th and 14th, moths appeared 16th to 22d and on to October 1st.

The moth expands from eight-tenths to nearly one inch; body very slender and usually a little less than half an inch long. Antennæ naked quite slender, and tapering towards the tips; legs rather stout. General color of the upper side a pale ocher-yellow shaded with brown in front and along the lateral margin, lighter portions slightly iridescent. Examined more closely, the front wings are found to be divided into two areas by the colors, the inner (anterior) half, except the costal margin, pale semi-transparent usually with a very distinct iridescent reflection, sometimes coppery. The outer half and anterior costal margin fuscous-brown; near the exterior angle an elongate yellow dot, bordered posteriorly and interiorly by a dark, often black shading. Secondaries or posterior wings pale yellow, transparent, usually with a distinct coppery luster, a dusky space at the exterior angle. The color of the fringe corresponds with the color of the wings.

Underside of a pale coppery yellow, the depth of color corresponding with the color of the upper side.

Abdomen compressed, dark brown with paler rings at the sutures; eyes very dark brown or black, antennæ vary in color, some are dark brown almost black, others rather pale.

The original description by Guenee is as follows: "Length 27mm. The anterior wings of a yellow ocher color very pale, shining, and iridescent, powdered with blackish in places; with the two median lines blackish, oblique, parallel and strongly and irregularly denticulated. A cellular blackish spot rather large, somewhat interrupted. An oblique apical point limited posteriorly and interiorly by a black shading. Posterior wings much paler, with a triangular dash at the apex, and a denticulate line of blackish. North America; one female."

As before stated, they eat elongate holes between the veins of the leaves; sometimes continuing to enlarge these until only the veins are left. They will often bore directly into a head for the depth of two or three leaves, whereas, so far as I have observed, the larva of *Pieris rapæ* will not bore into a firm head, they will manage by gnawing at the outer leaf to cause it to draw slightly away from the head and then eat holes in it; but the larva of the *P. rimosalis* will bore, at least for a short distance, directly into a firm head. They appear, as a general rule, to prefer working from the inner or upper side of the leaf, but there does not seem to be any great uniformity in this respect.

I have not as yet, noticed any parasite preying upon them, though it is probable another season will bring some little friend of this kind to our aid.

The same remedies tried upon the European cabbage-worm were tried on this species, in fact the two worms worked very harmoniously on the same cabbage, the butterfly larva, as is well known being of a proverbially quiet and peaceable disposition, avoiding as far as possible encroaching upon the premises of other insects. But this species appears if possible to be still more tenacious of life than the imported worm; it will eat away apparently unconcerned when literally coated over with lime; salt and brine seem to have no effect upon it; strong ashes and weak lye will kill some, especially the younger ones, but to no great extent unless of sufficient strength to injure the cabbage. Other applications were also tried with little or no better effect

but the time allowed for experimenting was not sufficient to exhaust the various means which may be resorted to.

I think it probable a flock of chickens would have aided me more than all the applications, but unfortunately these had been banished from the garden for injuring the tomatoes.

Their smaller size renders it more difficult to pick them off than the other worms.

It also feeds with equal avidity on turnip and horse radish leaves.

I think it quite probable that this is a southern species, which, like the Rice weevil (*Sitodrepa oryzae*) made its appearance in this latitude through the influence of the more than usually long continued warm weather of the past autumn. It is undoubtedly two if not three brooded in a year. If I am correct in this opinion, it is not likely that Illinois will ever be seriously troubled with it so long as our seasons remain as they have usually been.

The limited group to which this species belongs is widely distributed over the world, most of them in the larva state, feeding on cruciferous plants, one only, the cabbage-garden Pebble Moth (*Pionea forficalis*), appears to injure cabbage and other useful vegetables in Europe. The caterpillar of this species is found in May and June and the second generation in September and October. It has a light brown head and a yellowish green body, with black stripes running length-wise, and blackish dots, having fine white lines between and white incisions and spiracles. It is quite common in England and on the continent and often does serious injury to the cabbages and horse-radish. No effectual method of destroying them has been found except picking them off by hand and killing them, which is very difficult in large patches.

The discovery of the habits of our native species is quite interesting as it shows the great similarity in habits of species which are considered closely allied by their external characters; and is a strong confirmation of the correctness of the present system of classification.

THE CABBAGE PLUSIA.—*Plusia brassicae*. Riley.

This species, which was first described and named as distinct by Prof. Riley in his second report, was previously either overlooked or confounded with the European *Pl. ni*. Engr., the close resemblance of the two having led Guenee to consider them as identical. Until recently, Mr. Grote, who has made the group to which this belongs a special study, and who is perhaps our best authority in reference to the *Noctuidae*, was disposed to consider the two as one species, but he now decides the *brassicae* to be a good species, an opinion concurred in by Drs. Zeller and Speyer, and I believe most Lepidopterists.

A short account was given in my second report, but I have concluded, as it is a true cabbage insect, to give its history and charac-

teristics more completely, and to illustrate these by reference to congeneric species. I do this because it is difficult to determine a species, particularly of the moths, from a single description, without a possibility of reference to the descriptions of other species, especially when specimens of the same genus are found in the same sections.

Although the Cabbage *Plusia* appears every year in greater or less numbers, it does not appear to be generally so injurious as to require any special effort for its destruction; its development in injurious numbers being only occasional, and then only in places where large quantities of cabbages are raised, as in the vicinity of larger cities.

The moth may be readily distinguished by the following characteristics, which are generally quite uniform. Expanse of the wings 1.25 to 1.50 inches. Front wings narrow and wedge-shaped, as is usual in this group; of a dark, grayish-brown color, a pale spot near the base between the prominent veins; near the middle, two small silvery-white spots, the inner one, which is the larger, of an irregular U-shape, with the opening forward, the interior space usually marked with a slender fulvous line; the outer one close to the base of the former, and sometimes connected with it, is round or oval in form. These spots are usually very distinct, and bright silvery-color, but occasionally are dull, and sometimes scarcely distinguishable, but seldom, if ever, entirely wanting in both wings. Usually a scarcely distinguishable band, slightly paler than the ground color, crosses the wing towards its outer margin; the fringe of the outer margin is of the same color as the wings, and is dentated. Hind wings smoky, with a coppery lustre, darkest toward the outer margin; fringe pale or whitish, with darker inner line. Underside smoky, that of the front wings darkest, with a pearly, varying on the hind wings to a slightly coppery lustre.

The thorax dark grayish-brown; abdomen more or less fulvous; that of the male with a very distinct tuft of bright fulvous or yellowish hair on each side of the fifth segment, folding over the back of the following segments.

The larva or caterpillar, which when fully grown is usually a little over an inch long, has but twelve feet, the three pairs of anterior or true feet on the first three segments behind the head, two pairs of abdominal feet situated far back, and the two on the last segment.

Its general color is pale yellowish green, with about six or eight longitudinal paler lines on the dorsal portion of the body and extending back to the tenth segment; the posterior extremity of the body is the thickest, from whence it tapers gradually to the head; the anal segment sloping abruptly downward. The pale lines are not always distinct.

When fully grown they form a very loose white silken cocoon, so delicate that the chrysalis is distinctly visible through it. The chrysalis is rather slender and varies in length from .60 to .75 of an inch; the dorsal portion olive or brown, the ventral pale yellowish-white; the proboscis case is very distinct, extending back of the wing cases to the seventh segment.

I have failed to notice the eggs, but they are doubtless similar to those of the closely allied European species, *Plusia gamma*, Linn, which are turnip-shaped, or oblate spheroids, with delicate ribs and sculpturing, and according to Curtis, are generally attached to the underside of a leaf, in considerable clusters, though Sepp represents them as laid singly. The larvæ of this species, as is the case with

all the *Plusias*, on account of the long abdominal space without legs, have to bend upward, or loop the central portion of the body in moving, and hence may be classed among the measuring or span-worms, so far as the method of progression is concerned. They eat large, irregular holes in the leaves of the cabbage, but do not appear to be confined to this plant. They spin their cocoons and pass the larvæ state between the leaves, or in some sheltered place. The European species, *P. gamma*, to which it appears to be quite closely allied, occasionally appears in great numbers on the continent, doing incredible mischief to the market gardens, eating up the peas and beans, so that only the stalks and fragments of the leaves are left; whole fields of culinary plants have been consumed by them, and even crops of hemp. It is therefore possible that under favorable conditions our species may develop in such numbers as to be seriously injurious.

Curtis, from whose work on *Farm Insects* these facts are obtained, remarks that: "These extraordinary swarms of insects, and their irregular returns, may be sometimes owing the mildness of the foregoing winter; in the instance just related there had been no severe frosts either in the winter or spring, so that the previous autumnal broods of caterpillars lived through the cold season, and it necessarily followed that an immense number of the moths were produced, and the spring and summer which succeeded proving favorable to their increase, they became more abundant than they had ever been known before."

We may remark here in passing, that this species,—*P. gamma*,—is a widely dispersed insect, being found not only all over Europe, but also over a large part of Asia and even in North America.

The *Plusia* moths, unlike most of the *Noctuidæ*, fly about in the day time, in sunshine as well as in dull and even damp days. But they are exceedingly shy and difficult to catch.

The number of broods of this species in a season, is yet a matter of some uncertainty; that there are two, is evident from the fact, that the larvæ reared by myself, and also those by Prof. French, were taken in August and appeared in the perfect state about the first of September. This brood usually remains in the pupa state about two weeks or a little less. The proper care in making our collections would probably have decided this point, but attention not having been called to it before, it was overlooked. But it is quite certain we have two if not three broods; that it is three brooded in the southern states, is rendered certain by the fact that Mr. Grote records its capture in Alabama as early as February 20th.

According to Stephens, there are three broods of *P. gamma* in England, the first appearing in April, the second in June, and the third in September. Curtis states, that in France it is most abundant in July and October. Duponchel, in his catalogue, says it is found "all the year." From the same catalogue we learn that the moths of the European species, here named, make their appearance, or rather are found, as follows:

Orichalcea. F. Switzerland. In July.

Bractea. F. Alps. In August.

Aurifera. H. Spain and France. In July.

Testacea. L. Europe. In June and August.

Chalcites, Esp. Italy and France. June and August.

Accentifera. Lef. Sicily, Corsica and Spain. June and September.

Iota. L. Northern France, etc. June and September.

Ni. H. Central France and Italy. June and August.

Gamma. L. Europe. All the year.

The following dates, at which collections of the moths of our native species were made by Mr. C. E. Worthington, about Chicago, copied from the *Canadian Entomologist* of April, 1879, will be valuable in this connection:

<i>Plusia aerea</i> .	Hub.	August and October.
“ <i>contexta</i> .	Grote.	August and October.
“ <i>biloba</i> .	Steph.	May, August and October.
“ <i>verruca</i> .	Fab.	September.
“ <i>dyaus</i> .	Grote.	September and October.
“ <i>precationis</i> .	Guen.	June and October.
“ <i>ou</i> .	Guen.	Sept and October.
“ <i>brassicæ</i> .	Riley.	September and October.
“ <i>oxygramma</i> .	Gey.	September and October.
“ <i>simplex</i> .	Guen.	June and October.

From this it would appear that at least one species—*Pl. biloba*—is three-brooded as far north as Chicago. Most of the species in this list have been observed by us, in the southern part of the state, but almost uniformly a month earlier than here given.

The mode in which *Pl. brassicæ* passes the winter does not appear to have been noticed; but judging from the delicate character of the cocoon, the position in which it is usually found, the dates at which the moth is found and its apparently hardy character, it is quite probable that it hibernates in the perfect state.

Remedies.—As the species has appeared but a few times in injurious numbers, at least in the west, and then only in limited localities, no particular efforts to destroy them have been made, and no special experiments with topical or other remedies have been instituted. It is probable the larvæ are more easily killed than those of the cabbage butterfly, or Cabbage Pionea; but until special experiments are tried it is impossible to say what will be most effectual.

The various applications mentioned in the foregoing article on the European Cabbage-Butterfly will suggest what may be tried on the caterpillars of the species now under consideration, should it become seriously injurious.

Curtis suggests the employment of ducks as an aid; the same suggestion was made to me a short time ago, by a practical farmer, when speaking of the cabbage worms. Young ducks and young chickens would be most efficient aids, if taken away when they attain a size at which they commence to injure the young cabbages and other plants, but this is not until they are about half-grown, or nearly large enough to fry. A brood will soon learn, as I know by actual experiment, to start out together in the morning and feed across the garden in one direction, picking off the worms and other insects; then wheel and march across in the opposite direction, and so on until supplied. This will be repeated two or more times during the day.

Remarks.—As some knowledge of the characteristics, preparatory states and habits of congeneric species, especially as the genera are now restricted, will aid in determining and also in forming a correct

opinion in reference to our injurious species, I present here notes on other North American and some of the more noted foreign species.

The following list, taken chiefly from Grote's check-list, contains about all the North American species that have been determined. I have placed opposite the names, so far as I have been enabled to do so from the data at hand, the localities where they have been observed:

1.	<i>purpurigera</i> ,	Grote.	
2.	<i>æreoides</i> ,	Grote.	New York.
3.	<i>ærea</i> ,	Guen.	New York, Illinois.
4.	<i>balluca</i> ,	Guen.	New York, Canada.
5.	<i>metallica</i> ,	Grote.	
	<i>bractæ</i> ,	Grote.	
6.	<i>contexta</i> ,	Grote.	New York, Illinois.
7.	<i>putnami</i> ,	Grote.	New York.
8.	<i>striatella</i> ,	Grote.	Atlantic States, Canada.
9.	<i>thyatiroides</i> ,	Guen.	New York.
10.	<i>formosa</i> ,	Morr.	New York.
11.	<i>mappa</i> ,	G. and R.	
12.	<i>bimaculata</i> ,	Steph.	New York.
	<i>u-brevis</i> ,	Guen.	
13.	<i>biloba</i> ,	Steph.	Illinois.
14.	<i>verruca</i> ,	Fabr.	Illinois.
15.	<i>dyaus</i> ,	Grote.	Illinois, Texas, Jamaica.
16.	<i>precationis</i> ,	Guen.	New York, Illinois.
17.	<i>laticlavata</i> ,	Morr.	
18.	<i>labrosa</i> ,	Grote.	
19.	<i>monodon</i> ,	Grote.	Cape Breton.
20.	<i>sackenii</i> ,	Grote.	Colorado.
21.	<i>gamma</i> ,	Linn.	Europe, California, British America.
22.	<i>pseudogamma</i> ,	Grote.	Cape Breton.
23.	<i>ou</i> ,	Guen.	Illinois.
24.	<i>fratella</i> ,	Grote.	Texas.
25.	<i>u-aureum</i> ,	Boisd.	New York.
26.	<i>8-scripta</i> ,	Sanb.	Anticosta Island Racine, Massachusetts.
27.	<i>viridisignata</i> ,	Grote.	Canada.
28.	<i>brassicæ</i> ,	Riley.	Illinois, Missouri.
	<i>ni</i> ,	Grote.	
29.	<i>oxygramma</i> ,	Guen.	Illinois.
30.	<i>mortuorum</i> ,	Guen.	New York.
31.	<i>epigæa</i> ,	Grote.	New York.
32.	<i>ampla</i> ,	Walk.	New York.
33.	<i>diasema</i> ,	Dalm.	
34.	<i>pasiphæia</i> ,	Grote.	California.
35.	<i>parilis</i> ,	Hubn.	Russia.
36.	<i>simplex</i> ,	Guen.	Illinois, New York, Colorado.
37.	<i>alticola</i> ,	Walk.	Colorado.
	<i>ignea</i> ,	Grote.	
38.	<i>hochenwarthi</i> ,	(Hoch.)	Labrador, British America.
	<i>divergens</i> ,	Fabr.	
39.	<i>divergens</i> ,	Hubn.	
40.	<i>pedalis</i> ,	Grote.	Kansas.
41.	<i>illustrata</i> ,	Guen.	Hayti.

It is not claimed that this list of localities is by any means complete, as it is made up from my own collection and some two or three brief lists which are at hand. It is more than probable that most of the species found in New York will also be found in Illinois. For the benefit of the entomological students of Illinois who may desire to determine species, and in order to enable those injured by *Plusias* to know the guilty species, I give here descriptions of species known to be found in Illinois, and of a few others which will probably be discovered here.

PL. AEREA, Guen.

Front wings triangular, very sharp at the apex, which is falcate; outer border gibbous a little behind the middle; the inner border straight in the middle portion, but suddenly curved at the anal angle, forming a kind of tooth; of a deep violet brown, with an irregular, darker line running from the anal angle to the apex; about three partial and somewhat confused lines of the same color and parallel to the first, most distinct on the inner half; the anal angles often with a saffron tint or luster. Posterior wings paler, of an almost uniform ocher-gray, with a faint coppery or golden luster. Underside of all the wings with a strong brassy luster, the disk of the front pair dark, the borders light; fringe pale. The head and prothorax heavily covered with saffron yellow hairs; the thoracic tuft with the anterior portion more or less yellowish, rest dark or pale brown. Abdomen pale, iridescent. Expansion of the wings 1.35 to 1.45 inches.

This species is without the silvery marks on the front wings so common in this genus. Is found throughout the state.

PL. BALLUCA, Guen.

Front wings very acute at the apex and strongly falcate; of a silken, yellowish gray; the median and subterminal spaces, with the exception of the cellule, of a brilliant greenish yellow or pale olive color; the space next the base of a more silvery shade. The two oblique transverse lines which separate the spaces, very slender, brown; the inner separates distinctly the two spaces, it curves in passing through the cellule, and is straight, but oblique, from the nerve to the posterior or inner margin. The middle space is without the usual metallic spots. The posterior wings of a clear, uniform, silvery gray, without markings; their underside of a clear, pale, uniform shining yellow. Underside of the anterior wings with a slight purplish shade. Head and prothorax honey yellow; rest of the thorax gray; tufts of the abdomen usually sprinkled with yellow. Expanse 1.80 to 1.90 inches.

Hubner figures the posterior wings with a black lunule, but the specimen before me is without this mark, and Guenee says it was also wanting in his specimen.

PL. AEREOIDES, Grote.

Front wings with the apex somewhat acute and slightly falcate; general color yellowish brown, with a fuscous shade across the inner

space; a rather darker, irregular band across the outer space, and faint indications of three narrower bands across the middle space, the one next the base forming the inner transverse line or corresponding very nearly with it; no metallic spots; the outer transverse line narrow, but very distinct, brown, bending at the middle, but nearly straight from there to either margin and nearly parallel with the margin of the wing; a single, very slender brown line along the outer margin at the base of the fringe; veins rather more than usually distinct and dark. Posterior wings an almost uniform fuscous, with a slight ochreous shade; underside straw color, with two incomplete, rather narrow bands and a discal splotch of pale brown. Underside of anterior wings ochreous, with shadings of purplish brown. Head and prothorax pale honey yellow. Expanse 1.35 to 1.40 inches.

PL. CONTEXTA, Grote.

Fore wings a little narrower than in *festucae* or *putnami*, external margin a little straighter, of the same brilliant colors, but the ground tint is more as in *festucae*, more of vivid brown, but not rosy as in *putnami*. The course of the median lines is the same as in its allies, but they are hardly as distinct. The light golden, metallic spots are fused, so that they come to have somewhat the appearance of the spots in *biloba*; the base of the compound spot is straight; the upper margin of the spot does not extend above the median vein. The golden portion of the apical shade is more extended inwardly and superiorly than in either of its allies, reaching inwardly to the reniform dot. Fringes of both wings pinkish. Hind wings pale fuscous; beneath, both wings pale rosy or ochrey-fuscous, with faint transverse lines. Varies in the extent of the orange-red powdering of the wings, so that some specimens seem higher colored than others. Expanse, 1.35 inches.

This species, if not in fact a variety of the European species, *festucae*, is the closely allied representative of it.

PL. BILOBA, Steph.

Anterior wings of a rich purplish-brown, with darker and lighter shades, palest toward the outer margin; the subterminal line, or line crossing obliquely near the outer margin, slender but distinct and marking the boundary between the shades; in the outer field, or space beyond this and near the apex of the wing; usually, behind this is a small brown dash running directly outward to the middle of the outer margin, the middle field, containing the silvery spots, purplish-brown except the spots, often some bronze or golden scales along the posterior part of the subterminal line, and silvery scales along the curved inner transverse line. The silvery spot is much larger than usual and consists of two pear-shaped lobes, the smaller ends pointing inwards; in front of the outer lobe, midway between it and the costa, is a short bent silvery line. Apical angle rather sharply defined but not falcate. Posterior wings smoky yellow, darkest toward the outer margin, with a bronze or coppery luster. Underside of an almost uniform, strongly marked bronze color. Head and thoracic tufts ferruginous brown; abdomen pale. Expansion, 1.4 to 1.6 inches.

PL. DY AUS, Grote.

This species appears to be closely related on one side to *verruca* and on the other to *precatationis*. The ground color is a pale lilac-brown with a tinge of gray. The front wings are marked, especially on the middle portion, with a strong bronze or golden luster; between the large veins near the base a pale, orbicular, silvery spot; the usual metallic or silvery spots on the disk small, but distinctly separated from each other, the outer or posterior one orbicular; the inner or anterior in the form of a U, with the inner limb the longer, the interior space fulvous, this fulvous portion extending obliquely forward to the costal margin; the outer transverse line separating the middle and outer third of the wing, sinuous, bordered outwardly, on the outer and inner portion by lilac-gray; the inner margin of the middle portion bordered by a strongly golden-tinted space; the outer margin, along the base of the fringe, marked by a straight, slender, pale lilac line; the fringe lilac-gray, slightly mingled with brown. Posterior wings pale lilac, with fuscous shading, darkest toward the outer angle, with pale fringes. Underside ochreous, the hind wings with two dull fuscous lines. Collar and face of dorsal tuft olivaceous.

It evidently approaches very near to *precatationis*, but the metallic spots are silvery instead of golden, the hook or U-mark more rounded at the angle; it is a little smaller species, paler and of a less distinct purplish tint. Expanse 1.35 inches.

PL. PRECATIONIS, Guen.

The front wings and thorax of a deep purplish-brown color. The inner transverse line, which marks the division between the basal and middle area, is formed by a slender thread of golden scales, obliterated toward the costal margin, the outer transverse line indicated by a narrow purplish shading, with a strong forward bend opposite the outer metallic spot; the fringe, which is pale lilac, is preceded by a very slender, pale inner and then by an outer, black marginal line, and is interspersed with black; the darkest portions of the wings are the space around the metallic spots and the interior portion of the outer area (considering the wings as spread). The metallic spots have more of a golden hue than those of the species heretofore described, they are also distinctly separated and prominent; the outer or posterior, ovoid; the inner or anterior, when seen from the base of the wing, resembles an interregation point (?) but seen from behind when the wings are spread, resembles an Italic *v*, the open part turning forward and inward. The posterior wings dark uniform fuscous, with a coppery luster. Under side dull ochreous, somewhat dusky; the posterior pair crossed by three fuscous lines, two of which are partially visible on the anterior wings. The anterior part of the collar a bright red. Expanse 1.50 inches.

The ground color of this species resembles very closely that of *biloba*, but the wide difference in the metallic spots and larger size of the latter readily distinguish it. The metallic spots of *precatationis*, *dyaus*, *ou* and *brassicæ* somewhat closely resemble each other in size and shape, but other differences sufficiently distinguish them from each other.

PL. VERRUCA. Fab.

Anterior wings of a violet-gray, with a deep golden luster, with two bands of gold sprinkled with brown; the first broad, starting from the inner border and ending at the cellule, interior portion straight, the exterior portion with a sharp sinus near the fourth inferior nervule; the second occupying all the terminal space, cut interiorly into large sharp teeth. Upon the first, immediately below the cellule, are one or two little guttiform, silvery spots with a golden centre. The space next the base and the place of the reniform spot, thickly sprinkled with gold. The posterior wings a dull gray, paler at the base; beneath, pale with a large subterminal band and a partial fuscous costal line. Head and base of the collar reddish saffron color.

Expanse 1.3 inches.

(Guenee).

PL. OU. Guen.

General color a silken grayish-brown. The front with the apical angle rather sharply defined; shades of dark brown alternating with ashen-gray; the spot between the large veins near the base oblong, dull ash color with a slight silvery luster; the inner transverse line obliterated; the outer crenated, corresponding with it is very distinct gray band which extends in a straight line from the costal margin, near the apex, to a point a little below and behind the outer silver dot; between this and the outer margin is an irregular, crenated, dark line more or less distinct; a slender gray line runs along the outer margin, interrupted, on the side next the fringe, by dark lunules; fringe indistinctly scalloped, gray with alternating dark rays. Metallic spots silvery, rather small, the posterior, orbicular or guttiform very close to the other; the anterior, when seen from behind (the wings being spread), is in the form of an irregular Italic *u*, the opening forward and the inner limb curving inward towards the base of the wing; seen from the base of the wing it strongly resembles an exclamation point (!); from this, a pale indistinct dash of gray extends obliquely forward and inward (wings being expanded) to the subcostal vein. Posterior wings of a coppery brown, quite dusky towards the outer margin; fringe pale, interrupted with brown. Under surface similar to the upper surface of the hind wings; the latter crossed by two very indistinct lines. Head and thorax rather dark ashen gray.

Expanse 1.50 to 1.60 inches.

PL. SIMPLEX, Guen.

Front wings with apical angle well defined; anal angle somewhat dentate; general color grayish brown; middle space behind the metallic spot dark brown; the inner or basal space and anterior portion of the middle space dark ash color, with a slight purplish tint, sprinkled with black points; the interior transverse line, which separates the basal and middle areas, a very oblique, straight, narrow silvery line, which runs from the posterior margin of the wings to the inner point of the metallic spot, where it stops; the outer transverse line

slightly waving or somewhat crenate and not very distinct, the outer space of two shades, the inner portion darkest and brownish ash color, but somewhat paler than the middle area, its outer margin tolerably well defined, marginal portion paler ash color; fringe concolorous, with brown dots at the tips of the veins; metallic spot single, silvery, narrow and shaped like an italic Y, that is, an oval dot with the inner end prolonged in two arms to the nerve. Posterior wings dark fuscus, with a broad, pale ochreous, curved band across the middle and a pale orbicular spot on inner portion near the band; fringe pale, with brown points. Underside bronze, somewhat fuscous, with a distinct brownish band across both wings. Head very small; it and the thorax gray.

Expanse, 1.40–1.50 inches.

I have two specimens that appear to belong to *precaionis*, with the silvery spot precisely as in *simplex*.

PL. OXYGRAMMA, Guen.

Front wings subdentate, large at the extremity, with a very prominent anal tooth preceded by a distinct sinus; of an ashen gray, satin color, shaded with roseate, and clouded with darker gray, with the lines scarcely visible; the two median waved, roseate, with dark bordering; the subterminal blackish, slender and dentate, with the teeth sharp and following one another in a line parallel to the border, upon which, in a certain light, can be seen the little black chevrons, the same as those on the subterminal. The "sign" [usually metallic] is here non-metallic, long, clear, and slenderly bordered by yellow. The reniform spot, straight, small and concolorous but visible. Posterior wings of a blackish-gray, paler at the base. Tufts of the abdomen large, especially that on the first segment; and extremity of the male garnished with blackish, silky hairs; there are also two lateral tufts of the same color which arise from the fifth segment and connect with the anal tuft.

The antennae are larger than those of any other *Plusia*. (Guenee.)

I have before me a female of what appears to be this species. The general color of the front wings is a dark ashen gray, with brownish markings in the middle space; the apical angle is slightly rounded; the inner transverse line not distinguishable; nor is the outer one well marked; the *sign*, or metallic mark, is narrow, sharp pointed toward the outer margin, with the sides of the inner portion parallel, the outer lines of it are metallic, the inside or space within yellow, but not metallic; the anal tooth is well defined. It expands 1.40 inches.

PL. PUTNAMI, Grote.

This pretty species is easily distinguished by the large golden spaces sprinkled over with orange, at the base and tip of the front wings; one of these is an elongate narrow spot on the costal margin at the immediate base; another large trapezoidal spot extending backward from the metallic spot to the inner margin; another at the apex, only partially covered with orange. The metallic spot is large, silvery, with

a slight golden luster, and composed of two lobes; the inner much the larger of the two and triangular, the forward angle rounded and extending into the cellule; the outer ovoid, and sometimes scarcely joined to the other; rest of the wing an orange brown. Posterior wings pale fuscous; underside yellowish, with an indistinct, narrow, sinuous brownish band across the disk. Head bright orange yellow; anterior part of the tufts of the thorax orange brown. Expanse 1.25 to 1.30 inches.

There are doubtless other species which have been or will be found in Illinois, but these are the only ones known to me at present as inhabitants of our State. The following brief notes in reference to other species which may possibly be met with when our insect fauna has been more thoroughly studied, are given as slight aids in detecting others than those described.

Pl. metallica, Grote. Appears to be the American representative and possibly but a variety of *Pl. bractea*, w. v. The latter has the anterior wings marbled with purplish-brown and gray; the metallic spot large, angulated and golden. Expansion 1.7 inches.

Pl. bimaculata, Steph. (*u—brevis*. Guen).—Head, thorax and abdomen purplish-brown; front wings varied with fuscous brown and ferruginous, apical angle rounded. Two silver spots almost equal and strongly isolated; the first a *u* surmounted by a little crescent, thus—*u*; the second more flattened and broadly oval. Expansion 1.65 inches.

This genus, as has before been intimated, is very widely distributed over the world, almost every country having its representative. *Dyarus*, found in Illinois, is found also in West Indies; *gamma*, found in California and probably in British America, is common in all Europe and in Algiers; *verruca* ranges from Illinois to Brazil. There are also other species common to Europe and America, and several peculiar to the former. In Cayenne the genus is represented by *Pl. feisthamelii*; in Montevideo by *Pl. nu*; in Cape of Good Hope and Southern Africa by *Pl. angulum* and *limbirena*; in Madagascar by *Pl. anargyra* and other species; in New Holland by *P. argentifera*; in East Indies by *Pl. signata*, *verticulata*, and other species; in Northern Africa by *Pl. aurifera*.

The Ural region and Eastern Europe, especially Hungary and Austria, appear to be represented more profusely than any other section of the eastern continent.

What has already been stated in reference to the habits and characteristics of the larvæ of *Pl. brassicae* and *gamma* is, as a rule, true of the larvæ of the other species of the genus. They are attenuated in front, have but two ventral feet and hence loop in walking; and live exposed on the plants on which they feed. Many of them are general feeders, while others are confined to a single species or genus. The cocoon is usually very loose and composed of finest silken threads.

The larvæ of *Pl. modesta*, a European species, feeds on the leaves of *Pulmonaria angustifolia*, and appears in April and May; that of *Pl. gamma* appears in April, June and August, is a very general feeder on low plants; *Pl. iota* feeds on nettle, archangel, burdock, etc. *Pl. interrogationis* on *Urtica urens*; *Pl. chrysites* on nettles, burdock, thistles, etc. *Pl. orichalcea* on hemp agrimony (*Eupatorium cinnabrium*); *Pl. festucae* on bulrush (*Pypha latifolia*); and *Pl. balluca* on the hop. *Pl. simplex* feeds on nettle, burdock, etc.

So far as known the larvæ are always of a general greenish color, variously marked.

THE PAINTED MAMESTRA.—*Ceramica picta*. Harr.

The larva of this species, which is known as "*The Zelra*," is one of our most beautiful caterpillars. When fully grown it is nearly two inches long, almost uniform in size throughout, with the segments more than usually elongated, the head small and short; sixteen footed. It is marked throughout its entire length with very distinct stripes, alternately black and yellow arranged as follows; a rather broad velvety-black median stripe along the back, narrowly margined on each side with white; next to this, on each side, there is a bright yellow stripe about equal in width to the former, in the middle of this, on each segment, there is a small black dot; next below this comes a rather broad blackish line, crossed transversely by numerous minute white and somewhat netted lines; next below this is another bright yellow stripe; below this, and just above the legs, is a narrow white stripe profusely sprinkled with black dots. The head, ventral surface and legs are pale reddish-brown or tawny. The surface of the body is almost entirely free from hairs. Dr. Harris describes the broad lateral stripe as "white traversed by rune-like black lines." It is difficult to tell which predominates in this stripe, the white or the black; the stripe is composed of numerous minute alternating white and black lines forming a kind of net-work.

Dr. Packard gives the following characteristics of the younger stages of the caterpillar:

"In the young, before the first molt, the head is as wide as the body, pale greenish, while the body is pale greenish, with a double, dark, livid, dorsal stripe divided by a pale median line, and three lateral dark stripes, the upper-most of which is the narrower; five pairs of abdominal feet, the first pair one-half as large as the fourth pair. The body is tuberculated, being much smoother in the fully grown larva. Length a little over a line. After the first molt, when the worm is a little over three lines in length, the colors are much as in the fully-fed larva, being deep yellow, with a broad, black, dorsal band, sometimes entire and sometimes divided by a median pale line. A lateral area is marbled with transverse, short black and white lines; and with a row of conspicuous black spots. A row of dark spots down on the sides. Head reddish testaceous; abdominal feet reddish. After the the third molt, when the caterpillar is one inch long (observed September 16), the markings are nearly the same as the mature caterpillar."

The moth, which expands an inch and a half, has the front wings of a bright purplish-brown color, with a slightly paler brown shade in the middle; the usual spots are rather dim, with a third oval spot behind the round one, more or less distinctly marked; they are all edged

and traversed by faint whitish lines forming a kind of delicate network; toward the outer margin there is a transverse, zigzag, whitish line forming a rude and wide w more or less distinctly visible; a few pale atoms are sprinkled on other portions of the wing. The posterior wings white and delicate, faintly edged with brown. The head and thorax brown; the abdomen grayish-brown.

There are two broods in each year; the first brood of the caterpillars appearing in June, the second in August and September.

It passes the winter in the chrysalis state; this at least appears to be the usual method.

Although apparently preferring cruciferous plants, the caterpillars feed with avidity on the leaves of the pea; and Prof. Riley has observed that the fall brood collects on the heads and flower-buds of asters and snow-berry, on the honey-suckle, mignonette and asparagus; and that they are also occasionally found on clover and lambs-quarter. When young they are gregarious.

So far the injury to cabbages caused by this insect has not been sufficient to call any special attention to it.

This species, which was formerly known by the scientific name *Mamestra picta* given to it by Dr. Harris, is supposed to be the same as Guenee's *Ceramica exusta*. The latter genus, in which it is now placed, contains but few species, the one here described being the only one, so far as known, that is injurious to useful plants.

THE CABBAGE TINEA.—*Plutella cruciferarum*. Zell.

As I have had no opportunity of studying this species personally, I will quote somewhat fully Dr. Fitch's excellent account of it as given in his Second Report; first remarking that he describes it under the name *Cerostoma brassicella*. It was also subsequently described by Dr. Clemens, under the name *Plutella limbipenella*.

In the neighborhood of Ottawa, Illinois, in October last [1854], I observed the cabbage leaves in the gardens perforated with numerous holes of variable size and irregular form, by a small green worm. Some gardens were so much infested that all the outer leaves of the cabbage were literally riddled with holes, more than half their substance being eaten away. At almost every step, numbers of the little moths which hatch from these worms would arise upon the wing and flit away a few yards to some covert. Fortunately it is only the free outer leaves of the cabbage which are preyed upon by this worm, whilst the compacted inner leaves, forming the head, on which the value of this vegetable depends, are left uninjured. But there is no doubt the eating away of the outer leaves, to such an extent as is frequently done by this worm, weakens and stints the growth of the head, which, as is well known, continues to advance in size until the end of the season.

It is a little remarkable that this species occurs in all its states so late in the autumn as the middle of October, as the several British

moths which are co-generic with it all make their appearance in July and August. It is hence altogether probable that there are two generations of the moth in each year; and if so, the first generation will make its appearance, it is quite likely, in the month of June, or at all events before the heads have begun to form, and when all the leaves are young, open, and adapted for its resort. It will consequently be liable, then, to do great injury to this vegetable.

This worm in its appearance, motions and habits, has a close resemblance to the Palmer worms which have recently stripped the foliage from our orchards and forests so extensively, to which, as we shall presently see, it is related. When it is disturbed it runs briskly backwards, with a wriggling motion or by a fine cob-web like thread lets itself down from the leaf. Its castings are little black grains, which appear like gunpowder sprinkled thickly over the leaves and the ground beneath them. The pupa or chrysalis is enveloped in a pretty gauze-like cocoon, which may be found attached to the eaten leaves, two or more of them frequently in a cluster together. It is spun of clean white threads, crossing each other and forming an open net-work, through the meshes of which the enclosed chrysalis may be distinctly seen. The threads composing the net-work are coarsish and not very stout. They may be readily broken with the point of a needle, and the enclosed pupa be thus removed from its case for examination, though the cocoon is so slightly attached to the leaf that it is frequently torn loose in thus breaking it open.

Interspersed with these gauze-like cocoons upon the leaves, others may be met with quite different in their appearance, being opaque and of a thick paper-like texture and a brown color. They are of an elliptic form, rounded at both ends, and only about the tenth of an inch long and a third as broad. These have been constructed by the larvæ of parasitic Ichneumon flies, which have destroyed the worms of the cabbage-moth. And from the information I possess it appears that this parasite deposits but a single egg in each worm, from which a maggot hatches, which feeds internally upon the worm, yet without attacking any vital part whereby the worm would be prematurely destroyed. Thus the parasite, as in other cases of this kind, attains its growth at the same time that the worm reaches maturity, when the maggot finishes its work by destroying the little that remains of its foster parent, and immediately incloses itself in this paper-like cocoon. Of three mature worms which I enclosed in a small box over night, only two were found next morning. All vestiges of the third had disappeared, and in place of it was one of these paper-like cocoons.

But as the worm of the cabbage-moth is such a choleric mercurial little fellow that when he is molested, be it ever so slightly, he darts backwards and wriggles about so suddenly and spitefully, it will be an interesting topic for some future observer to notice by what artifice his mortal foe induces him to remain quiet or is able to cling to him long enough to puncture and drop an egg within his skin.

The knowledge and skill which these Ichneumon and other parasitic Hymenopters often show in their proceedings is truly wonderful. Every person will recollect the larva of the Isabella tiger-moth (*Arctia Isabella*)—the large caterpillar with stiff even shorn hairs of a tan-color and black at each end of his body, which crawls about our yards and even enters our dwellings—and will probably have observed the fact that if when crawling he is rudely touched, he suddenly stops

and doubles himself together for a moment, and then straightens himself again and resumes his journey. The long stiff hairs with which he is protected, much like a porcupine, we should think would render it impossible for an insect enemy to place an egg anywhere upon his skin. Mr. P. Reid tells me he once saw one of these caterpillars crawling with a hurried, eager step across a dusty road, with an Ichneumon fly pursuing him, striving to cling upon his back, but falling off in consequence of the rapid motion of the caterpillar. The fly finding itself frustrated in its every effort, next, as if humming to itself the refrain "'Twill never do to give up so," flew a few feet forward of the caterpillar, and turning darted back with all his energy, hitting the caterpillar square in his face. The caterpillar thus roughly assailed suddenly stopped and bent himself together in his accustomed manner, and in an instant the fly alighting upon his back, appeared to fix an egg at the margin of one of the breathing pores, which had become fairly exposed by the caterpillar doubling his body thus together. In a moment the caterpillar was recovered from his shock and was crawling rapidly forward again, when the fly struck him a second time in the same way and thus he was stopped and had an egg deposited upon his side three times, before he reached the tall grass beside the highway, in which he was secure from further molestation. And it is probable^r that by some artifice equally curious and remarkable, the parasite of the cabbage-moth is able to drop an egg into the skin of his irritable, brisk motioned victim.

This moth pertains to the genus *Cerostoma*, of Latreille and the British entomologists, a genus belonging to the family TINEIDÆ, and intimately related to that to which the Palmer worm pertains—both genera having the feelers with a tuft of scales projecting forward like a beak, from the middle of which beak the slender terminal joint stands upwards like a little horn. The larvæ of the two genera are also identical in their appearance and habits. The genus *Cerostoma* is described as differing from that of *Chaetochilus*, in having the wings narrower and rounded at their ends, differences which are so slight as to be scarcely discernible on a comparison of this species with the moth of the Palmer worm. The antennæ narrower, are directed forward instead of being turned backwards and lying upon the back; but this is a character which is liable to be deceptive, except when observed in the living specimen. The light color of the inner margin of the wings, however, and the lace-like cocoon of the pupa, leave no doubt that it is the genus *Cerostoma* to which our insect must be referred.

Stephens (Illustrations, Haustellata, vol. iv, p. 341) says the spiral tongue in this genus is "shortish," while Westwood (Humphreys' British Moths, vol. ii, p. 245) gives it as "long and slender." The latter is certainly its character in our insect, where it is about equal to the antennæ in length. Our species is closely allied to the *C. porrectella*, Linn., the worm of which Mr. Westwood found feeding upon the buds of the White Rocket, a plant of the same family with the cabbage, and which forms an open net-work cocoon the same as our species.

The worm of the cabbage moth is nearly cylindrical in its form, rather thickest in the middle, and slightly tapering towards each end. It is over a quarter of an inch long, measuring when full grown 0.35, and is the thickness of a coarse knitting needle. It is varied in its color, but is most commonly pale green, of the same hue as the cabbage leaf. Some are of a deeper tinge and others paler, varying to greenish

yellow or pale yellow. Often the hind part of the body is paler than the fore part. Frequently the head, or the apical segment, or both, are pale yellow, the rest of the body being of the usual green hue. Individuals may sometimes be met with having the head dusky or black with dusky clouds. The neck is frequently tinged with red. Commonly a stripe along the middle of the back is more or less distinct, of a deeper green color or blackish in places; and on each side of the back a similar stripe may be discerned, whilst low down on each side a whitish stripe is sometimes apparent. With a magnifying glass the body is perceived to be clothed with several short black hairs, which proceed from minute black dots, each of which is surrounded by a faint pale ring. These dots are symmetrically arranged, and are situated the same as in numerous larvæ of moths, each of the segments of the body having four of them above, placed at the angles of an imaginary square, of which the anterior side is the shortest; while on each side are four other dots placed at the angles of an imaginary rhombus, the upper and lower angles of which are very acute. There are numerous dots on the neck, and the head is commonly freckled with a number of dark brown dots.

There are sixteen legs and the two first segments of the abdomen at first glance appear to be furnished with legs also, being bulged on their under sides, so as to touch the surface on which the worm stands.

The *chrysalis* or pupa is one-fourth of an inch long by 0.05 in width. It is commonly of a white color, with large, deep black eyes situated inside of the base of the antennal sheaths. Quite frequently the white color is varied with umber-brown stripes, whereof there is one on each side of the back, with a very slender brown line between, upon the middle of the back. The wing sheath is brown upon the upper margin, with a brown stripe in the middle and a more slender one inside of it, parallel to each other, and both running into the marginal stripe, this last being prolonged upon the abdominal segments to the tip. The sheath of the antennæ and of the legs are also brown. These brown stripes remain upon the pupa skin after the moth has been hatched from it, but the black color of the eyes then disappears.

The winged moth measures 0.30 in length to the tips of the closed wings, and these, when expanded, measure 0.58. It is of an ash-gray color. The fore wings are freckled with black dots on the disk and apex and have a common white stripe on their inner margin reaching to the hind angle, which stripe is wavy upon its inner edge and near the middle of the wing is bordered by a dark brown streak; the fringe of these wings is traversed by one or more blackish lines which are parallel with the margin. The hind wings and also the undersides of both pairs are leaden-brown, glossy, and without any spots or dots. The antennæ and the underside of the abdomen are white. This moth is somewhat variable in the depth of its color, being frequently dark gray, and the stripe on its wings is not always pure white and distinct.

Facts so far as observed indicate that when this and its kindred species are favored with unusually dry weather at the date of their appearance in the larva state, the species suddenly becomes excessively multiplied, overrunning particular sections of country like an invading army. When I observed this cabbage worm a drouth was prevailing

through northern Illinois, that was said to be without a parallel since its settlement. And hence we infer that thoroughly showering the vegetation, which is attacked, with water, will be found a most effectual remedy for the expulsion of the worms of this group. With the cabbage moth this measure can easily be resorted to, a common watering pot being the only apparatus which is required.

Insects and Other Parasites Affecting Domestic Animals.

It is so very common for persons who have devoted no special attention to the humbler forms of animal life to include all of the minute animal forms under the term *Insects*, that the Entomologist is frequently called upon to give the history, habits and remedies for small parasitic animals which do not belong to the Insect class.

Having frequently received letters of inquiry in reference to insects and parasites affecting domestic animals, I have concluded to devote a portion of the present report to this subject.

In order to make clear what I may write on this subject I will first call attention to some generalizations respecting the arrangement and classification of the lower groups of animals, including those which we shall have occasion to mention.

Mammals, or such animals as man, the horse, cattle, hogs, sheep, dogs, cats, etc., are subject to the attacks of a large number of minute animals belonging to the great sub-kingdom *Articulata*, or articulate animals. By some recent authorities this large group has been divided into two or three sub-kingdoms, but for present purposes the older arrangement will suffice, although confessedly somewhat defective.

The sub-kingdom *Articulata* is generally defined as that division of the animal kingdom embracing all animals which have the body made up of a series of rings or joints, with the skeleton or harder parts external; the nervous system chiefly on the ventral side. This definition, although applying generally, is subject to many exceptions; as many of the species included present no apparent rings or segments in the body; in some the nervous system appears to be almost or entirely wanting. We can perhaps designate the group more satisfactorily to the general reader by saying that it includes all such animals as insects, centipedes, spiders, ticks, mites, lobsters, crabs, shrimps, leeches, earth-worms, tape-worms and other intestinal worms.

As will be seen from this list, it embraces a vast number of different kinds or species of small animals; more, perhaps, than all the other divisions of the animal kingdom combined. Although some of the subdivisions present considerable difficulty in attempting to classify them by distinct characters, and place them in proper positions in relation to each other, yet naturalists, after much study, have succeeded in arranging them in a manner generally acceptable to scientists.

The arrangement which we here present is the one most generally adopted at the present day.

Subdivisions of Articulata.

- Sect. I. **ARTHROPODA** or True Articulates,—Those articulates having the body distinctly divided into segments; furnished at some time of life with articulated locomotive organs; the nervous system consisting chiefly of a double chain of ganglia running along the ventral side.
1. Class *Insecta*.—Three pairs of legs in the perfect state; abdomen destitute of limbs; one pair of antennæ; head, thorax and abdomen distinct; usually with two pairs of wings; air breathers. Contains all the true insects.
 2. Class *Myriapoda*.—Legs numerous, usually more than eight pairs; head distinct, remainder of the body composed of similar segments; one pair of antennæ; air breathers.
Contains the centipedes, millipeds, etc.
 3. Class *Arachnida*.—Four pairs of legs; no true antennæ; head and thorax amalgamated into one piece; breathing various. Contains spiders, ticks, mites, scorpions, etc.
 4. Class *Crustacea*.—Locomotive appendages more than eight; two pairs of antennæ; head and thorax amalgamated into one piece; water breathers.
Contains the lobsters, crawfish, shrimps, crabs, sand-fleas, etc.
- Sect. II. **Vermes** or Worms.—Division of the body into segments usually not so distinctly marked and sometimes wholly wanting; never furnished with articulated locomotive appendages; nervous system usually less perfect than in the preceding section.
5. Class *Annelida*.—Body showing segmentation but not so distinctly marked as in the preceding section; without any distinct head in the true sense; the nervous system as in the preceding section. The segments very numerous and similar, except those at the anterior and posterior extremities of the body.
Contains the leeches, earth-worms, sea-worms, etc.
 6. Class *Scolecida* (Helmintha or Entozoa).—Body usually without apparent segmentation, though in some cases this is distinct; without locomotive appendages; the nervous system very imperfect or wanting; with the exception of two orders, are internal parasites.
Contains the tape-worms, cyst-worms, flukes, trichina, ribbon-worms, thorn-headed-worms, hair-worms, round-worms, wheel animalcules, etc.

We shall have occasion to refer to 'species of but three of the classes here mentioned, to-wit: Class *Insecta* or Insect class; Class *Arachnida* or Spider class; Class *Scolecida* or Intestinal Worm class. As I have in a previous report noticed the orders of insects, it is unnecessary for me to do so here.

The Class *Arachnida* is usually divided into three orders, as follows:

- Order 1. *Araneina*, or True Spiders.
 Order 2. *Pedipalpi*, containing the scorpions, false scorpions and daddy long-legs.
 Order 3. *Acarina*. Containing the mites.

The third order—*Acarina*—is the only one of these we shall have occasion to refer to.

The Class *Scolecida* or *Entozoa* is a somewhat heterogeneous group, containing several orders differing very widely from each other in characteristics and habits. These are usually given as follows:

- Order 1. *Trematoda*. Containing the flukes.
 Order 2. *Cestoidea*. Containing the tape-worms and bladder-worms.
 Order 3. *Acanthocephala*. Containing the spine-headed worms.
 Order 4. *Nematoidea*. Containing the thread-worms, hair-worms, etc.
 Two or three other orders, which are not parasitic, are included.

This outline of the classification will suffice to give the reader an idea of the relative positions which the species we shall have occasion to refer to, occupy in this extensive sub-kingdom. These three classes contain all the minute animals which can in any sense be called parasitic. For example, in the Insect class we find such parasites as fleas, bed-bugs, lice, bot-flies, sheep-ticks, etc.; in addition to which there are many others, not true parasites, which direct their attacks more especially against man and domestic animals, as mosquitoes, the *Tabanidae*, or horse-flies; the *Simuliidae*, or black gnâts, etc.

In the spider class the principal enemies of man and beast are found among the mites and ticks, but these are counted by the legion, for almost every animal has its peculiar species.

In the class embracing the intestinal worms we find whole groups of species which appear to have been formed for the express purpose of making the internal parts of mammals their special habitation, as they are unable to exist anywhere else. The stomach, the intestines, the muscles, and even the brain and eyes have their peculiar species.

It will be seen therefore that to investigate thoroughly the various parasites that infest our domestic animals, it is necessary to examine into each of the three classes of Articulates named, and to pass beyond the boundary to which the work of the entomologist is usually confined.

SHEEP PARASITES.

This valuable and all-important domestic animal appears to be unfortunate, in being attacked by more than the usual number of parasites attacking the various species of mammals. It numbers among its enemies species from all three of the classes named; and what is of still more importance, is the fact, that it suffers more severely from these attacks than any other domestic animal.

THE SHEEP BOT-FLY (*Oestrus ovis* L.)

As this is a true insect belonging to one of the most numerous orders of the class, I will, before describing it, give a brief outline of the larger divisions of the order. The arrangement I will adopt is that given by Westwood in his "*Introduction to the Modern Classification of Insects*," not the latest, it is true, but sufficiently accurate for the present purpose.

As stated in my first report, the insect class is usually divided into about seven orders, as follows:

- Order 1. *Coleoptera*, containing the various kinds of beetles.
- Order 2. *Orthoptera*, containing the cockroaches, walking-sticks, grasshoppers, crickets, etc.
- Order 3. *Neuroptera*, containing the dragon-flies, lace-winged flies, etc.
- Order 4. *Hymenoptera*, containing the wasps, bees, hornets, ichneumon-flies, etc.
- Order 5. *Lepidoptera*, containing the various butterflies and moths.
- Order 6. *Hemiptera*, containing the true bugs, such as the bed-bug, squash-bug, chinch-bug, cicadas, plant-lice, bark-lice, etc.
- Order 7. *Diptera*, containing the two-winged flies, such as mosquitoes, house-flies, horse-flies, bot or breeze-flies, sheep-ticks, etc.

As will be seen from this, the bot-fly of the sheep belongs to the last order *Diptera*, or two-winged flies, but some, as the sheep-tick and other species, as is the case in some instances in the other orders, are without wings during their entire lives.

This order, as before intimated, contains an immense number of species and has been divided into numerous families which cannot be noticed here. On this account entomologists have divided the order into sections according to the character they conceived to be of most importance, the division by Westwood is as follows:

- Sect. I. Head always distinct from the thorax; claws of the tarsi not dentated or toothed; larva annulose, not undergoing its transformation to the perfect state within the body of the parent.
 - Divis. 1. Antennæ composed of more than six joints; palpi four or five-jointed; pupa incomplete.
 - Musquitoes or Gnats, Crane-flies, Wheat-midges, Hessian-fly, etc.
 - Divis. 2. Antennæ short, not having apparently more than three distinct joints; palpi one or two-jointed.
 - A. Antennæ apparently composed of only three joints, the last however being articulated; proboscis exerted, seldom enclosing more than two lancets; the pupa coarctate, the skin of the larva, however, nearly retaining its previous form.
 - Contains mostly bright-colored flies found on flowers.
 - B. Antennæ with only three joints, usually with a bristle near the end, (*Tabanus* or horse-flies form an exception); proboscis exerted, usually with four, sometimes six lancets; larva with a scaly head; pupa incomplete.

Contains the horse-flies (*Tabanidæ*), robber-flies (*Asilidæ*), etc.

- C. Antennæ with only two or three joints, terminated by a bristle; proboscis generally concealed in the oral cavity; with two lancets (four in *Syrphidæ*); pupa coarctate, the skin of the larva forming an oval case.

The Syrphus-flies or Sweat-bees (*Syrphidæ*); house-flies (*Muscidæ*); the bot-flies (*Æstridæ*), etc.

- Sect. II. Head immersed in the thorax; claws denticulated or furnished with minute teeth; larva nourished in the abdomen of the mother until it passes into the pupa state.

Bot-ticks (*Nycteribidæ*), bee-lice (*Braulina*); forest-flies or horse-ticks and sheep-ticks (*Hippoboscidæ*).

The fleas (*Pulicidæ*), which Westwood places in a separate order, are now usually included among the Diptera.

The family *Æstridæ*, as stated above, includes the various species of bot-flies. One of the most noted of these is *Æstrus ovis* L., or the Sheep bot-fly.

The family (*Æstridæ*), which contains the bot and breeze flies, is very singular in some respects. Although in general appearance somewhat resembling a common house-fly, yet the difference is sufficient to be noticed at a glance by the unscientific observer. As a general rule, the body of the fly is stout and hairy, somewhat like that of humble bees. Their mouth is very imperfectly developed. In the sheep bot-fly this organ is so reduced that it is impossible for the insect in its perfect, or fly state, to take nourishment, showing thereby that it was intended by Nature that its period of imbibing food should be confined to its larval or maggot state. The larvæ of these insects are generally thick, fleshy, footless maggots or worms, which have the hinder margins of the segments or rings of the body furnished with minute spines, which point backward, enabling them to move readily in the confined situations in which they reside. The head is usually very small, and the mouth in some consists simply of fleshy tubercles, as those which reside in the skin of animals, while in those species which reside in the stomach and nostrils, it is furnished with two little hooks, by means of which they are enabled to hold on to their positions. Their great peculiarity consists in the strange situations they select to pass their larval state, which is the most important part of their existence, their perfect state being devoted wholly to propagation. The *Gastrophilus equi*, or horse bot-fly, selects the stomach of the horse as the abode of its larva,—Nature having furnished it with that instinct which directs it where to deposit its eggs, that they may be carried to the spot where the larva will be developed and find suitable nourishment.

The *Æstrus ovis*, or sheep bot-fly, on the contrary, selects the nostrils of its victims as the most appropriate place to plant its offspring.

The *Hypoderma bovis*, or ox bot-fly, plants its eggs in the skin of cattle, where they form tumors, in which the larvæ dwell. Another species of this same genus (the *Hypoderma tarandi*) is found in the skin of the reindeer.

The species of *Cuterebra* inhabit the internal organs of squirrels, rabbits, mice and other small animals. Other species infest dogs and other quadrupeds, and even the frog is said to have its bot-fly. Nor is man himself wholly exempt from their attacks.

But at present we are concerned only with the history and habits of the species which infests sheep. As a general, and until recently supposed universal, rule, the flies deposit eggs from which the maggots are hatched. But recently Prof. Riley, on the authority of Mr. Cockrill (who produces the statements of two other witnesses), and some facts known in regard to the habits of this species, arrives at the conclusion that it deposits living young. While the usual habits of the species of this family appear to be opposed to this idea, and the great difficulty of making direct observations might lead us to doubt the correctness of this conclusion, yet it is well known to entomologists that similar departures from normal habits do occur among insects, and the difficulty of the egg maintaining its situation until hatched would seem to favor this idea. Repeated dissections of gravid females would appear to be the only feasible means of determining this question. This appears, from Prof. Riley's statement, to have been done in two instances, showing living young. The parent fly deposits her eggs or larvæ, as the case may be, in the nostrils of the sheep. As soon as the larvæ are deposited or hatched, they at once commence to make their way up the nostrils to the frontal sinuses, causing great irritation to the lining membrane; here they attach themselves firmly by the little hooks with which the mouth is furnished, and feed on the mucus which is always found here. While young they are of a creamy-white color, except two brown spots on the hind segments, which are the breathing pores. When full-grown they are darker, varying from a dirty-white to a brown, the hinder portion being darker than the front; these differences in color represent, more or less distinctly, rings corresponding with the segments, not reaching around the body, but leaving a pale space along each side, which is marked by a row of brownish dots, representing the breathing pores. The under side is marked between the ventral rings with bands of minute dots or tubercles, which are tipped with little short spines, which, if examined with a magnifier, are found to be of a reddish color, and to point backward. It is now shaped somewhat like a beet, largest behind, and tapering to the head, which is quite small. Kollar states that it is without the ventral spines usually found in the larvæ of this group of insects, but, although minute and not easily seen, they are, nevertheless, present, for without them we could hardly explain its power of moving forward on the unctuous mucous membrane.

Having entered the nostrils in the middle of the summer, worked its way to the frontal sinuses, and gradually attained its full growth, it remains here until the following spring, when it loosens its hold and works its way down the nose, producing great irritation in the membrane and uneasiness in the animal, and drops to the ground. It rapidly burrows into the soil out of view, and in a short time, two or three days at most, transforms into a chrysalis. It remains in this state six or eight weeks, and then comes forth from its hiding-place a true two-winged fly, somewhat larger than the common house-fly, but resembling it in general appearance. The head and thorax are brownish; the abdomen consists of five segments, or rings, which are velvety, and variegated with brown and dull yellow, or, as Youatt has expressed it, "tiger-colored on the back, being prettily striped and marked."

As before stated, its mouth is so imperfect and undeveloped, that it may be said to have none. It is, therefore, wholly unable to imbibe

nourishment, its only mission now being to produce and provide a place for its offspring.

Such, in brief, are the characteristics and history of this pest of the sheep-fold; a history which leads up to the threshold of those difficult problems in the plans of the infinitely wise author of Nature—problems which we shall probably be unable to solve until human investigation has brought to light the most profound mysteries of nature, and is able to weave them into one continuous web.

The question raised by Messrs Youatt and Clark, as to whether these insects are really injurious to otherwise healthy sheep, I leave to practical sheep-growers to decide; taking it for granted, however, that the very large majority of sheep-raisers differ from these able veterinarians on this point, and very decidedly prefer that their flocks should always remain exempt from their attacks. It is more than probable, however, that fatal results are often attributed to them which are due to other causes, and that they, in fact seldom cause death to sheep otherwise healthy.

The remedies may all be classed under three heads:

1st. Change of situation to where they are less liable to attack.

2d. Measures designed to prevent the deposit by the mother fly.

3d. Removing the larva or grub after it has become seated.

That some situations are more infested than others I think will be found true. Kollar, who wrote for the benefit of Austrian agriculturists and gardeners, speaking of this insect, states that "young flocks are sometimes attacked by this plague when they frequently graze near woods." I am satisfied that high, dry, firm, open, airy situations will be found much less infested by this pest than low, moist situations, where there is thick undergrowth and close hot air.

There are various means adopted which are designed to prevent the deposit of the eggs or larvæ by the parent fly. the old and well-known method of tarring the nose is, perhaps, one of the best and simplest. The removal of the grub after it has become seated is difficult; putting something into the nostrils to cause severe sneezing is, perhaps, the only plan worthy of trial, for the barbarous method of trepanning the skull should not be resorted to. But the matter of remedies I leave to the practical sheep-raisers and the veterinary surgeon, as I claim no practical knowledge in this respect.

It is sometimes supposed by those who have not studied the character of the grub, that it may bore through the bony wall of the skull into the brain; but this is simply an impossibility, as it has no organs or weapons with which it can bore.

THE SHEEP TICK. (*Meolophagur ovinus*, L.)

The next species to which I call attention is the "sheep-tick" (*Melophagus ovinus*), which, notwithstanding its name, is not a tick in the true sense, but a wingless fly, and belongs to the same order—

Diptera—to which the bot-flies belong, but to a different and very singular family, which entomologists have named *Hippoboscidae*. These insects are distinguished by their flattened and somewhat horny bodies, the horizontal, flattened head, which is received into the front part of the thorax, and the rudimentary antennæ. Some of them possess wings, but others have these members aborted, or are entirely without them, as in the case of the sheep-tick. The front part of the body of this species is unusually small; the head is somewhat wider than the thorax, which is very narrow; the mouth, or proboscis, is as long as the head; the limbs are short and thick, and the abdomen, “which is broad and hairy, is not divided into rings, as that of flies usually is.” It is of a pale, reddish color; the abdomen is lighter, with an irregular white line along each side, and a red spot on the back.

The mode of reproduction in these flies is very singular and unusual. They produce neither eggs nor larvæ; the egg-duct or tube has an enlargement which produces a milk-like secretion for the nourishment of the larva, or young maggot; the egg—for they usually give birth to but one or two young—passes from the ovary to this enlargement, and hatches into a larva, which is nourished here, during this stage of its existence, upon the milk-like fluid before alluded to, until it passes into the pupa or chrysalis state, at which time it leaves the body of the parent. Instead, therefore of producing eggs or larvæ, they produce pupæ. Therefore, strange as it may seem, we see in this very low type of animal life a somewhat close imitation of the method of reproduction observed in the higher animals.

The remedies for this pest may be placed under two heads, as follows:

1st. A change of situation similar to that recommended in the case of the bot-fly.

2d. Measures for removing the ticks.

So far as the latter are concerned, I suppose the wool-growers present are doubtless familiar with the remedies suggested by Randall, Youatt, Clark, and other writers, which consist in dipping in decoctions of tobacco, arsenical solutions, applications of mercurial ointment, etc. To these I have nothing to add, as these, if properly followed, will suffice to eradicate them. As the only cure after they are on the sheep consists in eradicating the insects, this must be left to the ingenuity and practical knowledge of the shepherd. I have seen it stated somewhere that kerosene may be used with success, but I am not sufficiently acquainted with sheep to tell to what extent such remedies may be applied with safety.

THE SCAB MITE. (*Peoroptes equi*. Gerv.)

These little parasites, as the reader will learn from the introductory part of this chapter, are not true insects, but belong to the *Arachnida* or spider class and order *Acarina*, which contains the mites.

This order contains a very large number of species and has been arranged by Murray, a very recent English authority, into the following families and sub-families:

Subdivisions of Acarina.

Fam. 1. *Trombidiidæ.*

- Sub-fam. 1. *Tetranychinæ*, Spinning mites.
2. *Trombidiinæ*, Harvest mites.

2. *Bdellidæ*, Snouted harvest mites.
3. *Hydrachnidæ*, Water mites.
4. *Gamasidæ*, Insect mite-parasites.
5. *Ixodidæ*, Ticks.
6. *Halacaridæ*, Marine mites.
7. *Oribatidæ*, Beetle-mites.
8. *Acaridæ*.

- Sub-fam. 1. *Hypoderinæ*,* Subcutaneous mites.
2. *Hypopinæ*, Ichneumon mites.
3. *Tyroglyphinæ*, Cheese mites.
4. *Sarcoptinæ*, Itch and louse mites.
5. *Phytoptinæ*, Gall and bud mites.

The scab mite of the sheep, which is now believed to be the same species as that infesting the horse and ox, belongs to the eighth family, *Acaridæ*, and fourth sub-family, *Sarcoptinæ*, which also contains the human itch mite, or mite that produces the disease in man known as the itch.

The scab, as all are aware, is a skin disease analogous to the mange in the horse and itch in man, and, like these, is produced by a very small mite. It was for a very long time supposed that this mite was produced spontaneously, by an unhealthy and unclean condition of the flocks, or from insufficient or improper food, etc., and not from a preceding parent. According to Westwood, two such able entomologists as Burmeister and Kollar leaned to the idea of equivocal generation of these parasites. But such erroneous ideas as these in reference to these mites have at last been corrected—at least so far as authors and naturalists are concerned—as it is now known that they are produced from eggs, deposited by parents similar to themselves.

As before stated, the species belonging to the class *Arachnida*, are distinguished from insects and most other minute animals, by the fact that they possess four pairs of legs; though there are some exceptions to this rule among the mites, some of which, in the perfect or full grown state, and several in the immature state, having only three pairs.

The sub-family *Sarcoptinæ* is distinguished from the other groups of the family by the striated or finely grooved skin; by the suckers with which the feet are usually provided; and by being destitute of eyes.

* I have changed the termination of the sub-families to correspond with present custom.

Our parasite has received various scientific names, according to the fancy or opinion of authors; but, as the further history of its classification is unnecessary now, I will mention but two of these:

1st. *Dermatodectes ovis*, sheep-itch-mite of Gerlach, by whom it was considered as peculiar to sheep; but the most recent authority restores the name *Psoroptes equi*, horse itch-mite of Gervais, considering the species infesting the horse, cattle and sheep, as identical.

It is distinguished from the itch-mite of man (*Sarcoptes scabiei*, Latr.) by two or three important characters. The four anterior legs and two of the hind, at least, in the males of each species are furnished with sucking disks, placed on comparatively long pedicels or stems. In the itch-mite of man, so far as I can ascertain, these pedicels are only one-jointed. But the most important difference is, that the mouth of the human itch-mite is furnished with sharp scissor-like jaws or nippers, with which they can readily cut into the skin, and form their sub-cutaneous burrows. The sheep mite is furnished with comparatively slender, lancet-like mandibles, to the sides of which the little palpi, or mouth-feelers are glued, thus forming a sort of tube, one part of which is capable of piercing. But while this peculiar form of the oral apparatus enables them to pierce and suck, it deprives them of the power of cutting; and hence, notwithstanding the general opinion to the contrary, they are not sub-cutaneous in their habits, and do not form true burrows, as the human itch-mite.

It lays its eggs on the surface of the skin, to which they adhere by a gluey matter. The length of time these require to hatch in such situations is not positively known; but some, placed in a bottle and kept to the warmth of the body, hatched in fourteen days. The young which are produced from these have only six legs; but, after several changes of skin, or moultings, they acquire eight, which is the normal number of the class. With the little sucking disks of their feet they are enabled to cling firmly to the skin of the sheep. By piercing the skin with their lancet-like mandibles, irritation and a species of inflammation of the skin follows, and an exudation takes place, which ultimately forms the scab. As stated by a writer on this subject, "Examination will disclose spots on the skin, white and hard, the center marked with yellow points of exudation, which adheres to the wool, matting the fibre together. The wool may be firm on these spots, and no scabs are seen in this stage. Then the yellow moisture evaporates, gives place to a yellow scab, which adheres firmly to the skin and wool. Raw places appear at points which the animal can reach with its teeth and hind feet. The disease is complicated in summer by the presence of the larvæ of the blow-fly, the maggots burrowing under the scab."

The remedies are reduced to one class—those which have for their object the destruction of the mites and their eggs. In addition to the applications of arsenical and mercurial ointments, arsenical and tobacco washes, which are so generally recommended, the writer from whom I have just quoted strongly recommends a wash of dilute carbolic acid.

THE LIVER FLUKE—(*Distoma hepaticum*.)

Of the intestinal worms that attack sheep, we notice as the most important the Silver Fluke (*Distoma hepaticum*). This species, belonging to class *Scolecida* order Trematoda or "Suctorial worms" as given above, inhabits the gall bladder or ducts of the liver in sheep, and, as believed, causes the disease known as the "rot." It derives its common name from its resemblance in form, to the flounder, of which "fluke" is a Scotch and Old English name. It is somewhat broad and flattened, of an elongate ovate form, somewhat pointed at each end and is usually nearly an inch long, often much less, but occasionally more; its breadth at the widest part, which is towards the front, is about half its length. Its color is usually that of the organ in which it resides. It belongs to a very low type of beings; having neither eyes, true respiratory organs, heart, nor any other organ of special sense; the sexes are not even distinct, and the alimentary canal does not even pass through the body, but dividing and subdividing, permeates all parts of it, distributing the imbibed nourishment, which needs little or no assimilation to adapt it to use in forming the materials of the body. It is proper to state, however, that Youatt and other writers on sheep, distinctly affirm that flukes have eyes and even figure them. But what possible use they have for these organs, in the situation they occupy, it is impossible to say; and moreover, without nerves, of which there are but mere traces, these organs would be entirely useless, even if they were in the light. That they do possess eye-like spots at a certain stage of their life is true, but there is nothing to show that these are organs of sight or eyes in any true sense. What this author considers the heart and circulatory system, is probably the water vascular system found in these and all other animals belonging to this class, which is supposed by many to represent the respiratory system in the higher grades. He also supposes the eggs or spores, after being cast off, remain undeveloped until taken into the stomach by the sheep with its food, which, as will be seen, is an error.

The species belonging to this order vary considerably in their transformations and habits, some passing through a cycle of six forms while others present only three or four. Some infest the liver or hepatic ducts of vertebrates, others infest the intestines of birds and batrachians, the gills of fishes, or paunch of ruminants; while others are found imbedded in the vitreous humour and lens of the eyes of certain fresh-water fishes such as the perch.

The cycle of changes through which the liver fluke of the sheep passes has not been fully traced, but the life-history of *Distoma militare*, another species of the same genus, which inhabits, the intestines of water birds has been nearly completely traced, and from it we may, with what we know of the life of the liver fluke, form a somewhat correct idea of the history of its transformations.

This species, as stated, in its perfect or mature state resides in the intestines of certain water birds. The ova or spore-like eggs which it produces are few, some eight or ten in number. From each egg issues a ciliated larva, which still retains something of the character of an egg although active, as there is an outer envelope in which there is the real animal, or in which it is developed, its history at

this point of its life being yet imperfectly known. From this egg-like larva proceeds the second larva form which is known as a *Redia*. Its mode of development in this form is not fully known. It is now found attached usually to the body of some water snail (*Paludina*), the cilia of the first larva having now disappeared. When the *Redia* or this second larva form has acquired its complete growth it is somewhat of an arrowhead shape; consisting of a sac, within which is suspended a tubular bag containing colored masses, which Huxley supposes are alimentary. The head is represented by a kind of crown, and near the other extremity are two lateral projections. In the body cavity external to the tubular sac vesicles now appear which rapidly increase and assume the form of *cercarice*, the name given to the third larval stage. The *Redia* now bursts and these new *zooids* escape. This multiplication at an intermediate and incomplete stage, before sexual characters have appeared, is very remarkable and introduces to our view a strange feature in animal life.

The *Cercaria* resembles a peanut with a slender tail attached to one end; it also has lateral membranous attachments by means of which it swims after the manner of a tad-pole. After swimming free for a certain length of time it finally fixes itself upon and usually bores its way into the body of a water snail or some similar mollusk. The tail then drops off and the body encloses itself in a cyst. The coronal hooklets of the perfect form now appear. It now remains quiescent unable to develop further in its present situation; awaiting for some water-bird to swallow the mollusk in which it is imbedded. As soon as this is done, and the cyst set free in the alimentary canal of the bird further development begins and the complete or *Distoma* form is assumed. The body elongates and narrows anteriorly, the suckers move nearer the head and the circle of hooklets being complete, it attaches itself by these to the walls of the intestine.

Such is the strange life history of this intestinal worm; and although that of the liver-fluke may vary in some respects yet it is doubtless similar in a general sense.

The following outline given in my address before the Illinois Wool-Growers' Association, September 20, 1877, is probably substantially correct:

They produce a kind of spore or egg; but its subsequent progress, so far as it is at present known, presents one of those singular life-histories occasionally met with in the lower orders of animals. In some way, not well understood, this egg or germ spore makes its way to the external world; its history from this time until it is hatched is unknown; but moisture in some form is probably necessary to its development. It is next found in the body of some mollusk, as the snail, or some aquatic insect, where its form is so different from that of its after life, that it was long considered as appertaining to an entirely different group of animals. From these, in some way not yet ascertained, it passes into the sheep. It probably escapes from the mollusk or insect to herbage in moist places, or water, and is taken into the stomach of the sheep with its food or drink, and passes through the lacteals, and makes way to the ducts of the liver.

As sheep do not feed on mollusks, as the water-birds do, it is difficult to imagine how the *Cercaria* if it becomes encysted in the body of the mollusk, makes its way into the stomach of the sheep. It is possible this may be explained in one of two ways: First, as has

been stated above, the *Cercaria* is for a time a free swimmer and hence may be taken into the stomach by the sheep when drinking, or attached to herbage in damp places. Second, it has been ascertained by Van Beneden, that some species of this group pass to the mature state directly from the *Redia* stage without undergoing the intermediate or cercaria stage, as these are free they may be taken into the stomach in water or on damp herbage.

As before stated, these internal parasites are supposed to be the cause of rot in sheep, though many persons are inclined to believe they are a consequence, rather than cause, of disease. But all appear to agree that this disease is connected with the condition of the soil, or state of the weather, moisture being the element most likely to produce it. This corresponds exactly with the theory of its life-history which I have presented, and indicates the best means of preventing it, to-wit: give them well-drained, open, airy pastures, and proper protection in damp and rainy seasons. It is more than probable the condition of sheep is often attributed to this disease, when it is due to other causes. Randall asserts that he has never witnessed an instance of rot in the United States; yet I notice in the annual reports of the National Agricultural Department statements of large numbers dying annually of this disease.

For the numerous remedies which have been suggested, I refer you to the various works on sheep, and to the veterinary surgeons.

HYDATID OF THE BRAIN (*Coenurus cerebralis*).

Another very singular and fatal disease, known as turnsick, staggers and sturdy, or more correctly, "Hydatid of the brain," is caused by a parasitic worm belonging to the same class as that just mentioned, but to the order *Cestoidea*, or Tape-worm group. On examining the brain of a sheep which has died from this disease, a watery bladder, sometimes quite small, at others as large as a hen's egg, is found. It possesses a number of heads, which are distributed over the bladder, each having an oval orifice, surrounded by minute, sharp hooks, within a ring of sucking disks. On account of its numerous heads, it has sometimes been called *Hydatis polycephalus cerebralis*, or the many-headed Hydatid of the brain. With the sucking disk, they fasten themselves to the brain, and, by means of their hooklets, which appear to be a kind of ciliæ, it is supposed they imbibe food. The fluid of the bladder is usually clear, but sometimes turbid, when, if carefully examined with a microscope, it will be found to contain a number of minute, worm-like bodies or animalcules.

It has now been ascertained that these cystle or bladder worms, so far as their history has been traced, or early stages in the lives of tape-worms, these heads which are seen attached to the bladder ultimately forming the head of the tape-worm.

Prof. Huxley has presented strong reasons for believing that the minute worms seen in the bladder ultimately become the joints of the tape-worm, each of which, in turn, is capable of producing under favorable circumstances, another cystic, or bladder-worm. But the strange part of the history of these similar animals is the fact that these two stages of life cannot occur in the same animal; or, in other words, the cystic or bladder-worm in one animal will never develop into the tape-worm, until it passes into another animal. For example, the bladder-worm found in the flesh of the hog becomes the tape-worm in man; the bladder-worm of mice becomes the tape-worm in the cat; that of the hare the tape-worm of the fox; while that which produces hydatids in man becomes the tape-worm in the dog.

Taking these facts as a guide, I am led to believe that the bladder-worm found in the brain of sheep is but the early stage of a tape-worm found in some other animal; probably the wolf, dog, or some carnivorous animal. How it escapes from its bony prison, or is taken up, I do not know; but they are very tenacious of life, and may possibly pass into the stomach of other animals long after the death of the sheep, and still be developed. It is possible the history of this species has been traced; but, if so, I am not aware of it.

No adequate remedy has so far been found, nor is it likely there will be; but, fortunately, its occurrence in this country appears to be rare.

In addition to the foregoing, there are a few other parasites which occasionally infest sheep to an extent sufficient to do them considerable injury. Of these I simply mention the following:

Tænia plicata; or, the folded tape-worm. I am unable to give the history of this species; nor am I aware that it has ever been ascertained. From what we know of the life-history of other species, it is difficult to account for the presence of a tape-worm in a purely herbivorous animal. So far as known, the cystic, or bladder-worm, which is the young or preliminary stage of the tape-worm, is always found in a different animal from that in which the mature tape-worm occurs.

Ascaris lumbricoides.—The round worm of the intestine. These are worms which inhabit the small intestine; and, according to Mr. Spooner, on whose authority they are introduced here, it would appear to be the same species as that in man; but it is more than probable that the nematode worm observed was some other species of *ascaris*. These species are said to give rise, especially in lambs, to severe diarrhœa.

The foregoing is but a partial list of the insects and other parasites that infest domestic animals; and is given here because of the frequent calls on me in reference thereto. This is a subject that belongs more properly to the Veterinary Surgeon.

MANUAL OF ECONOMIC ENTOMOLOGY.

PART III.

THE ACRIDIDAE OF ILLINOIS.

ACRIDIDAE is the name of a family of insects belonging to the order ORTHOPTERA. This order, as stated in my first report, is distinguished from the other orders of insects by the following characteristics:

The upper wings are leathery, or parchment like, one overlapping the other more or less at the base and not meeting in a straight suture along the back as do the upper wings of beetles (except in the *Forficulidæ*); under wings thin and membranous, folding lengthwise like a fan; transformations incomplete, that is to say, there is no true chrysalis state as in the case of beetles and butterflies, but from the first they have the form of the full-grown insect, only differing in size and absence of wings; they undergo moults, but have no quiet, resting pupa stage in which feeding is suspended, but continue to eat from first to last with equal vigor, except during the short time they are undergoing their moults.

The order embraces a large number of species which differ much in appearance and characters, and are generally known in this country by the common names Earwigs, Cockroaches, Devil's-horses, Walking-sticks, Grasshoppers, Katy-dids and Crickets.

Each of these names represents a distinct family of the order, thus:

Earwigs—the family. *Forficulidæ*.

Cockroaches—the family. *Blattidæ*.

Devil's-horses—the family. *Mantidæ*.

Walking-sticks—the family. *Phasmidæ*.

Grasshoppers—the family. *Acrididæ*.

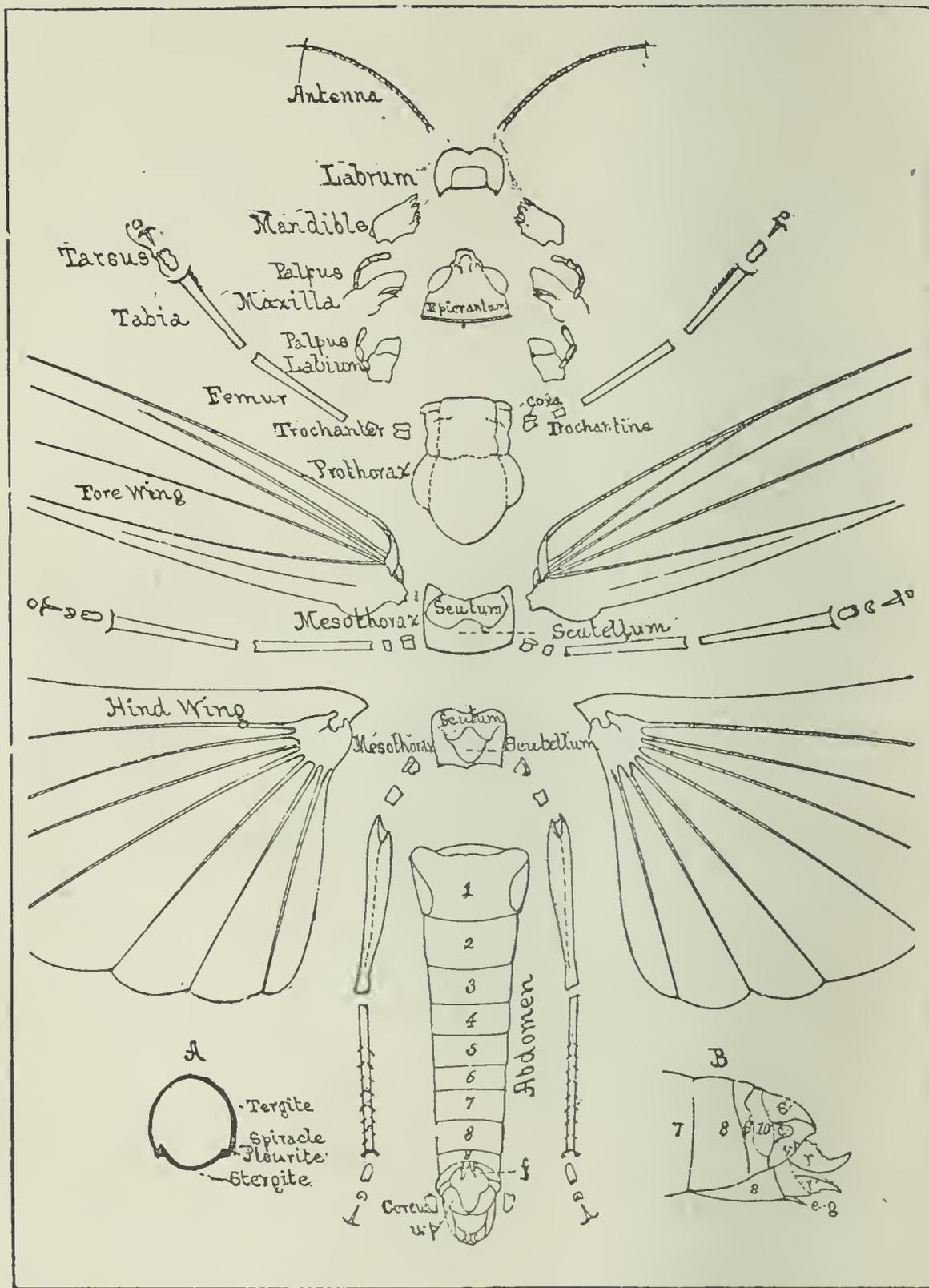
Katy-dids—the family. *Locustidæ*.

Crickets—the family. *Gryllidæ*.

Other insects and other families are included in the order by some entomologists, but there appears to be a general agreement that those mentioned here are properly embraced in it; besides these are all that can be included under the definition or characteristics given.

One difficulty experienced in attempting to convey to the general readers, who have devoted no special attention to entomology, correct ideas in reference to the species and groups of this order, is the fact that the popular names are so variously applied that they cannot be used without special explanation. For example, a true Earwig is an insect resembling a slender flattened beetle with short wing-cases; whereas the name is often applied, at least in parts of our state, to certain elongate, slender, many-legged centipedes found under stones, bark, etc., especially to the species of *Geophilidæ*. The name "Devil's Horse" is not uniformly applied to the Mantis, but often to our Phas-mae, or "Walking-sticks." The common name "grasshopper" has likewise been unfortunate in its use and application, not only in a popu-

FIG. 7.



External Anatomy of Locust (*Caloptenus spretus*. Thos.) showing the parts dissected, dorsal view.

A. Cross section of the abdomen.

B. Lateral view of the terminal segments of the female abdomen.

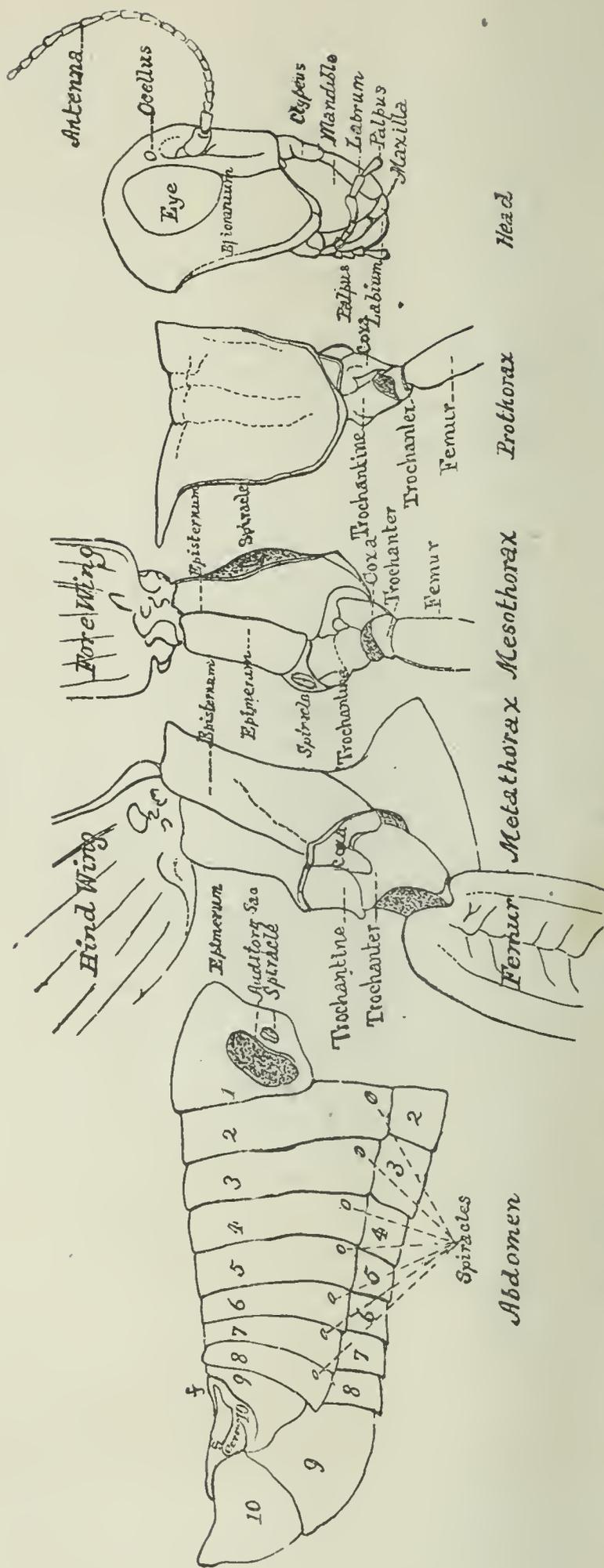
lar sense, but even by scientists, referring at one time to the true locusts (species of *Acrididae*), and at another to the *Locustidae*, or family including the katy-dids, and the greenish species with long slender antennæ that are found upon the higher grass, weeds and bushes. In fact the term, as generally used, applies to most of the species of these two families, the term "katy-did" including but a comparatively small portion of the *Locustidæ*.

The name "Locust" has unfortunately been applied in this country to an insect not even belonging to the same order as the locusts of oriental countries. The "seventeen-year locust" of North America is, in fact, not a locust, but a species of *Cicada*, or, as another species of the same group is often called, a "harvest-fly" or "dry-fly," belonging to the Order *Hemiptera*, which contains only insects with a mouth prolonged into a horny, jointed tube, formed for sucking the juices of plants; while true locusts have biting-jaws; or, as they are termed by the prophet Joel, "cheek-teeth." The grasshoppers which have appeared in such vast swarms and done so much mischief in the western states and territories are true locusts, and this term is gradually coming more and more into use in the proper sense.

Before entering upon the classification and description of our species, it will be best for me to explain the peculiar terms used, and the peculiar application of the general terms as they are used in describing species and genera of *Acrididæ*. The terms *head*, *thorax*, *prothorax*, *mesothorax*, *metathorax*, *abdomen*, *antennæ*, *femur*, *tibia*, *tarsi*, and the names of the mouth parts, are applied in the same general sense as in other orders, and as explained in my first report. The insect when described is presumed to be on its feet and the wings closed as represented in Fig. 10, (except, that in describing the under wings they are considered as spread.) The necessity for mentioning this fact is, that the relative terms *anterior*, *posterior*, *outer*, *inner*, *upper* and *lower* apply to the position of the insect or its parts, and unless these are known there will be confusion in the use of these terms. Anterior, before and forward, will then signify toward the front part of the head; posterior behind and similar terms, will signify toward the hind extremity of the abdomen; upward, above, toward the back, and the opposite terms toward the under or ventral side; lateral signifies toward or on the side; transverse, across the body or part described; and longitudinally, lengthwise of the body or part described. The term "transverse" is also often used to signify that the piece or part is broader than it is long, length always retaining the idea of the direction of the length of the whole insect.

The parts of the head which need special explanation are the following: The *clypeus*, the piece in front, immediately below the face, in the form of a transverse parallelogram, "tucked" at the sides; when the face is very oblique it is really underneath, but still the face is considered the front. The *frontal-costa* or *median carina* of the face, is the ridge which extends down the middle of the face; it is often grooved, when it is said to be *sulcate*, *sulcus* signifying a groove. Running down each side of the face there is usually a sharp ridge or raised line, called a *lateral carina*; the two forming the *lateral carinæ* of the face. The top of the head, which is really the back of the head in *Acrididæ*, is considered as divided into two parts by an imaginary line drawn across it from the hind margin of one eye to the hind margin of the other; the portion lying behind this line

FIG. 8.



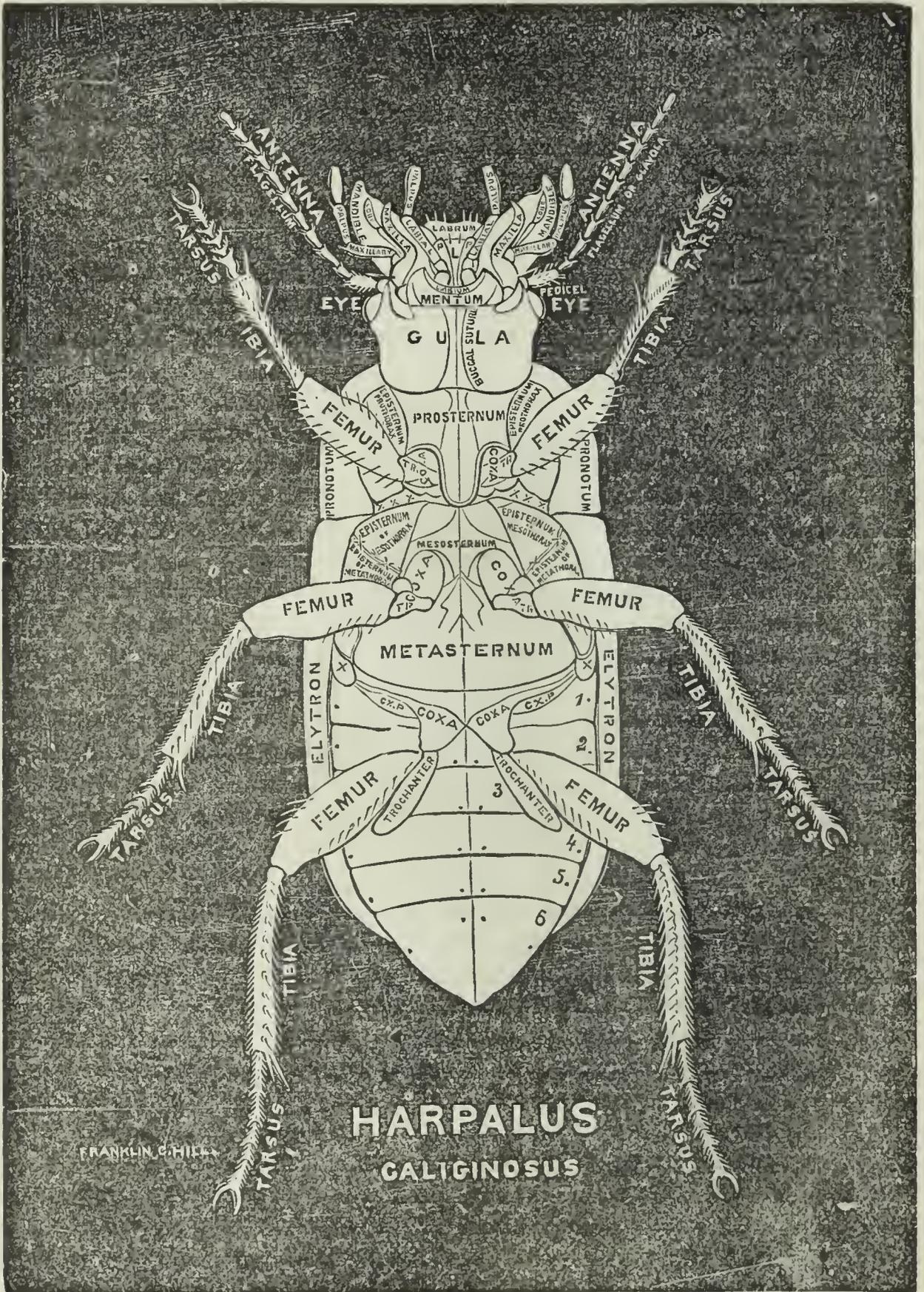
Lateral view of the external anatomy of the male Locust (*Caloptenus spretus*), showing the parts dissected

is the *occiput*; the portion between the eyes and extending forward to where the descent of the face commences is the *vertex*. The vertex presents very important characters in distinguishing genera and species and hence needs special explanation; in some species it ascends anteriorly, in some it is horizontal, but more usually is more or less deflexed, that is, sloped downward and forward; its extreme anterior point is the *fastigium*; sometimes the margins are raised so as to enclose a foveola or shallow cell between the eyes, which is called the *median* or *central foveola* of the vertex. The *lateral foveolæ* or *temporæ* are two small cells situated on the margin of the vertex, one on each side near the front border of the eye; sometimes on the upper surface near the edge; in other species, below the margin on the deflexed portion. These foveolæ are often very small and sometimes with so little depression as to appear flat, but on account of their uniformity are important characters. The simple eyes (*ocelli*, singular *ocellus*) are three little glassy dots placed as follows: one above the base of each antenna and near the inner margin of the true eye, and one in the frontal costa between the antennæ.

The thorax is, as in other insects, composed of three parts, or segments; the front part or *prothorax*, the middle or *mesothorax*, and the hind or *metathorax*; but the front division, on account of the fact that the upper or dorsal portion is generally enlarged in the form of a saddle-shaped shield hiding the divisions, is the one chiefly referred to in descriptions. This shield, which covers the front part of the body immediately behind the head, usually reaching down the sides nearly or quite to the insertion of the front legs, is the *pronotum*; it usually extends back on the dorsum of the thorax so as to cover the base of the elytra; in the sub-family *Tettiginae* it extends backward over the abdomen to its extremity; in a few wingless species it is not shield-shaped, but similar to the dorsal portion of the other segments. Its surface is considered with reference to three planes: the upper surface or *dorsum*, and the two sides or *lateral lobes*; where these three planes are well defined, the ridge or angle formed on each side along the line which marks the place where the lateral lobes deflect or bend down from the dorsal plane, is the *lateral carina* of the pronotum. But there are wide variations from this typical form; often the pronotum is so much rounded as to be almost or quite cylindrical when the lateral carinae are entirely obliterated; in some cases they are not only well defined, but in the form of raised lines or little ridges. In most species there is a raised line or keel running along the middle of the back or dorsum of the pronotum, called the *median carina*; this is sometimes but a slender thread-like line; in some species it is slightly elevated, when it is said to be *sub-cristate*; sometimes it is elevated into a very prominent sharp ridge, when it is called *cristate*. In many species there are three, more or less distinct, slender transverse grooves or depressed lines crossing the pronotum from side to side, one or more of which (usually the posterior) cuts the median carina. These are often referred to by the numbers 1, 2 and 3, commencing with the front one. In some groups the number, position and form of the notches made by these in the median carina form important characters. The portion of the pronotum in front of the first of these transverse grooves is the *anterior lobe*; that between the first and third, the *middle lobe* (or lobes); that behind

FIG. 9.

For the purpose of comparison, I give here an enlarged figure of a Beetle (*Harpalus caliginosus*), showing the names of the several parts.



the third, the *posterior lobe*. The *anterior margin* of the pronotum is the margin next the head; the *posterior margin* is the hind margin of the dorsal portion, and is usually in the form of an angle, pointing backwards, or is rounded, but in a few species is truncated or cut off squarely; the *posterior lateral margin* is the hind margin of the lateral lobes.

The *prosternum* is the underside of the prothorax or neck; it is either smooth, that is without a tubercle or spine, or it is furnished with a distinct tubercle or spine between the front legs, called the *prosternal spine*; the species furnished with this are said to have the *prosternum spined, armed or mucronate*; those without it are said to have the *prosternum smooth, or unarmed*.

The upper wings of *Acrididæ* are usually called *elytra* (which is the plural of *elytron*), though by some authors they are termed *hemelytra*, by others *tegmina*, and by others simply front wings. When the elytra and wings are spoken of together they are termed "wings."

The elytra are generally in the form of an elongate oval or an elongate parallelogram, narrowed at the base and rounded at the apex. In the perfect insect they usually reach to or extend beyond the tip of the abdomen; but there are numerous exceptions to this rule; in many species they are shorter than the abdomen, and in a few are wholly wanting. When the elytra are absent the wings are also wanting. A little experience will enable any one to distinguish readily between a full-grown, short-winged insect of this family and one yet in the pupa state. When the elytra are folded a small portion lies horizontally on the back, the remainder, and much the larger portion being deflexed vertically against the sides of the abdomen. When describing them they are considered as closed; the upper edge, which runs along the back is termed the *posterior, anal, or upper margin*, some authors using one of these terms, some another; *inner margin* is also occasionally used for the same part; the lower edge is the *costal, anterior or lower margin*; when "posterior" and "anterior" are used the elytra are then considered as spread. The area of each elytron is divided into three *fields* or spaces by two strong, longitudinal veins that start out from the *base* (part that joins the body); the larger of these, which runs a little distance from the costal margin, is the *externo-median* vein or nerve; the other which runs from near the middle of the base backward and upward toward the posterior or upper margin is the *interno-median* vein. The three fields into which the area is divided by these veins have received the following names: that between the externo-median vein and costal margin, is the *anterior, costal or lower field*; that between the interno-median vein and the upper or posterior margin is the *anal, posterior or upper field*; the middle area lying between these two veins is the *discoidal, intermediate or middle field*. The term *area* is often used instead of *field*, and is interchangeable therewith; the two words "vein" and "nerve" are likewise used interchangeably. The *angle* of the elytra is the longitudinal ridge formed along the interno-median vein by the sudden flexure from the horizontal to the vertical portion when closed.

When describing the wings they are supposed to be fully spread. The terms *disk* and *base* are sometimes, though not correctly, used synonymously, referring to the moiety of the wing next the body; the *disk* is really the central portion, and the *base* the part connecting with the body. The term *submarginal, or subcostal area* is used to

designate the space between the costal or anterior margin and the first strong vein behind. The nerves or veins are the ribs that run from the base to the outer margin, and from the lines of the folds when the wings are closed. The *nervules* or *veinlets* are the minute transverse veins running from one rib to another. The *anal* or *posterior angle* is the angle which stands near the tip of the abdomen when the wing is spread.

The parts of the abdomen which deserve particular notice are the following. The *cerci* which are two short processes issuing from the sides of the abdomen near its tip; one on each side arising at the base of the last segment and pointing backward; these, in some groups, are much larger in the male than in the female, and present important specific characters. The apex of the ventral (or under) portion of the last segment in the males, usually curves upward, somewhat in the form of the prow of a ship; in some species it is elongated and pointed, in others somewhat triangular and occasionally notched, and in others obtusely rounded; this portion of the last segment has been variously named, *sub-genital plate*, *subanal plate*, etc. The *pre-anal* or *super-anal* plate or lamina, is the triangular piece which in both sexes lies over the anal aperture; above and resting on the base of this plate is a little forked piece to which the name *super-anal furculum* has been applied. The *ovipositor* of the females consists of four short horny pieces projecting from the tip of the abdomen; two of which curve upward, and two downward; these are the *valves*.

CLASSIFICATION.

As explained in my first report, *Orders* are divided into *families*; families into *genera*; and a genus is composed of *species*. Besides these regular divisions in classification, there are often found to be characters by which well defined intermediate groups may be found; for example, the order *Orthoptera* will admit of two well marked sections, distinguished from each other by the fact that the species of one section have all the legs similar to each other in length, so as to fit them only for running or walking, and not having the hind legs elongated and fitted for leaping; while the species of the other section have the hind legs elongated and fitted for leaping. We may therefore call the first section, which includes the *Forficulidae*, *Blattidae*, *Mantidae* and *Phasmidae*, the *Cursorial Orthoptera*, or *Cursoria*; and the other, which includes the remaining families, as the *Saltatorial Orthoptera*, or *Saltatoria*.

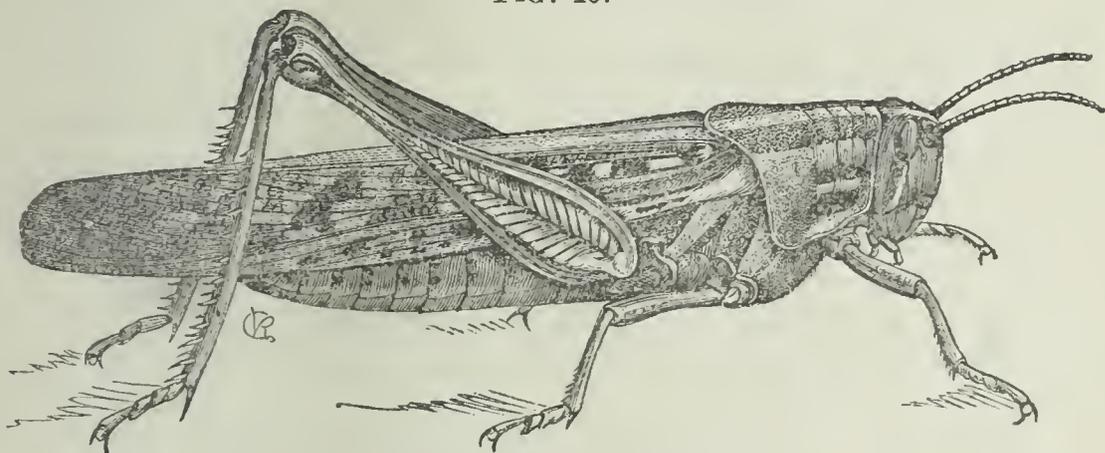
For convenience in locating genera and species, I have divided the family *Acrididae* into three sub-families: PROSCOPINÆ, ACRIDINÆ, and TETTIGINÆ. The characters by which these groups are distinguished from each other may be briefly stated as follows:

PROSCOPINÆ.—Body unusually elongated, cylindrical and slender, almost uniform in size throughout its length, and usually wingless. The

head elongate conical, and either ascending obliquely or extending forward horizontally; antennae very short, usually not extending beyond the tip of the vertex, and composed of from six to nine joints. The prothorax very long, slender and sub-cylindrical, having no pronotum in the sense of a shield, as in the other acridians; the pronotum here being simply the dorsal portion of the prothorax, as in the *Phasmae*, which they strongly resemble; the anterior legs are generally attached to its sides near the middle. The mesothorax and metathorax are very short, their combined length seldom equalling one-half the length of the prothorax. The hind legs scarcely fitted for leaping. No species of this sub-family are found in the United States.

ACRIDINÆ.—Of various sizes, from half an inch to four inches in length (the largest Illinois species does not exceed three inches). Tarsi furnished with a *pulvillus* or pad between the claws; pronotum, consisting of a kind of shield covering the prothorax and extending

FIG. 10.



Acridium Americanum.

backward, at the farthest, only upon the base of the elytra. In a few wingless species the pronotal shield is not well defined; and on the other hand in one or two genera it extends half way the length of the abdomen. Prosternum drawn up; that is, it is not in the same plane as the rest of the *sternum* or breast; spined, tuberculate or smooth, but never advanced upon the mouth. Elytra and wings generally present, but sometimes wanting; but when present the latter never exceed the former in length. This sub-family contains all the true locusts and most of the species to which the name grasshopper is usually applied.

TETTIGINÆ.—Generally of small size, many being less than half an inch in length, and few, if any, exceeding an inch. Tarsi, without pads between the claws. Pronotum, forming a shield over the entire body, extending back nearly or quite to and often beyond the tip of the abdomen; sometimes flat, sometimes keeled and arched, and in a few species elevated into a sharp, foliaceous crest. Prosternum depressed to the same plane as the rest of the sternum; advanced upon the mouth, and usually furnished with a semi-circular ridge, forming a kind of muffer into which the mouth may be drawn. Elytra and wings, when present, generally placed on the sides of the body, the latter exceeding the former in length.



Tettix.

Further subdivisions are sometimes introduced between the sub-family and genus, but it is unnecessary for us to allude to them at this time.

Having now explained the special terms used and the system of classification adopted in reference to this Order and the family under consideration, I will here introduce a short key to the Acrididæ found in Illinois, giving first a key to the families.

KEY TO THE FAMILIES OF ORTHOPTERA.

Families.

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| <p><i>A.</i> Legs similar in length; posterior not elongated nor adapted to leaping (<i>Cursoria</i>.)</p> <p><i>a.</i> Body depressed, oval or but slightly elongated; wings resting horizontally on the abdomen.</p> <p><i>b.</i> Abdomen armed behind with strong forceps.</p> <p><i>bb.</i> Abdomen not armed with forceps.</p> <p><i>aa.</i> Body more or less cylindrical; much elongated.</p> <p><i>b.</i> Anterior coxæ much elongated; anterior legs raptorial; prothorax much longer than the metathorax.</p> <p><i>bb.</i> Anterior coxæ not elongated; anterior legs similar to the others; metathorax much longer than the prothorax.</p> <p><i>AA.</i> Hind legs elongated, fitted for leaping (<i>Saltatoria</i>.)</p> <p><i>a.</i> Antennæ long, setaceous, composed of many joints; apex of the female abdomen furnished with an exserted ovipositor, usually more or less sword-shaped; elytra of the males furnished with a stridulating organ.</p> <p><i>b.</i> Outer portion of the elytra bent abruptly downward at the sides; tip of the abdomen furnished with two elongate pilose setæ.</p> <p><i>bb.</i> Elytra sloping obliquely downward at the sides like a roof; abdomen with two short, but not pilose, articulated appendages.</p> <p><i>aa.</i> Antennæ shorter than the body, composed of less than twenty-five joints; apex of the female abdomen furnished with four short, horny pieces, two curving upward and two downward.</p> | <p>1. FORFICULIDÆ.</p> <p>2. BLATTIDÆ.</p> <p>3. MANTIDÆ.</p> <p>4. PHASMIDÆ.</p> <p>5. GRYLLIDÆ.</p> <p>6. LOCUSTIDÆ.</p> <p>7. ACRIDIDÆ.</p> |
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As it is very difficult to construct a key to the genera, founded on characters that are readily observed, I will attempt to meet the difficulty by forming separate keys or synoptical tables; one for the groups or subdivisions of the family; one for the genera so far as this can be done with sufficient clearness to be easily understood; and one for our Illinois species. In each of these tables the characters are intended only to include the groups, genera and species represented in Illinois, and the arrangement therein given is artificial.

KEY TO THE SUB-FAMILIES AND GROUPS.

- A.* Pronotum extending back only to or but a short distance upon the base of the elytra; pads between the tarsal claws. Sub-fam. ACRIDINÆ.
- a.* Face distinctly oblique or sloped under toward the breast in both sexes; the prosternum not spined or tuberculated, except in *Mermiria*. Group 1. *Truxalini*.
- aa.* Face vertical or nearly so, sometimes curved near the clypeus, and sometimes slightly oblique in the male.
- b.* Prosternum neither spined or tubercled, except in *Stetheophyma*; where it is armed with a blunt tubercle. Group 2. *Oedipodini*.
- bb.* Prosternum armed with a distinct spine or tubercle. Group 3. *Acridini*.
- AA.* Pronotum extending back to or beyond the tip of the abdomen; tarsal claws without pads between them. Sub-fam. TETTIGINÆ.

KEY TO THE SUB-FAMILIES AND GENERA.

- I.* Pronotum extending back only to or but a short distance upon the elytra; pads between the tarsal claws; prosternum drawn up, not in the same plane as the sternum. Sub-fam. ACRIDINÆ.
- A.* Face distinctly oblique, or sloped under toward the breast in both sexes; prosternum sometimes spined, sometimes not. Groupe 1. TRUXALINI.
- a.* Prosternum armed with a spine; face very oblique. Gen. *Mermiria*.
- aa.* Prosternum unarmed.
- b.* Antennae enlarged and flattened near the base, tapering to the apex; face very oblique; sides of the pronotum parallel; elytra and wings longer than the abdomen. Gen. *Truxalis*.
- bb.* Antennae filiform, sometimes with the apical portion flattened and slightly enlarged, but never enlarged at the base (except in the female of *Syrbula*); face always distinctly, but sometimes only moderately oblique in the females.

c. Posterior margin of the pronotum truncate; vertex without foveolae; sides of the pronotum straight and parallel; elytra shorter than, or not longer than the abdomen; wings pellucid or but slightly tinged.

Gen. *Chloealtis*.

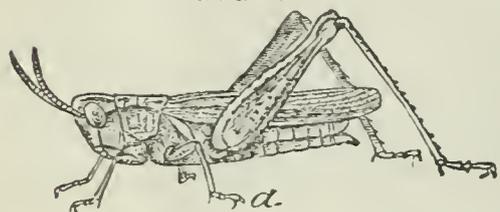
cc. Posterior margin of the pronotum obtusely angled or rounded; vertex usually with lateral foveolae; sometimes they are wanting; lateral carinae of the pronotum more or less curved, or bent inwards.

d. Male and female differing widely; in both sexes the elytra and wings pass the abdomen; face quite oblique; eyes ovoid and oblique; lateral carinae of the pronotum but slightly curving inward; posterior lobe of the pronotum somewhat elongate granulose. *Female*.—Antennae slightly enlarged and flattened at the base; foveolae of the vertex nearly or quite obliterated. *Male*.—With the antennae enlarged at the apex; foveolae of the vertex more or less distinct; an inner and discal area of the elytra with distinct parallel or scalariform nervules. Size one inch and over.

Gen. *Syrbula*.

dd. Male and female similar; nervules of the elytra

FIG. 12.



Stenobothrus maculipennis.
a. Perfect insect. b. Pupa.
c. Larva.

normal; antennæ never enlarged at the base, apex sometimes enlarged; lateral carinae of the pronotum distinctly curved or bent inward; foveolæ of the vertex more or less distinct; elytra sometimes shorter and sometimes longer than the abdomen. Seldom as much as an inch in length.

Gen. *Stenobothrus*.

AA. Face vertical or nearly so, sometimes, as seen from the side, curved near the clypeus, and sometimes slightly oblique in the male; the posternum spined in one group, in the other not.

a. Prosternum smooth or at most but slightly tumid, never spined or tuberculate (*Stetheophyma* forms a partial exception).

Group 2. OEDIPODINI.

b. Prosternum armed with a tubercle or tumid enlargement of prosternum.

Gen. *Stetheophyma*.

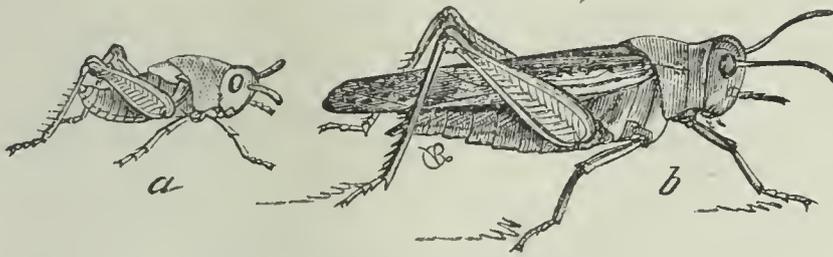
bb. Prosternum without a spine or tubercle.

c. Wings pellucid, neither colored nor clouded; pronotum with three distinct carinae, the median continuous; the lateral not elevated, very slightly curved inwards. Size less than medium.

Gen. *Camnula*.

- cc. Wings colored or clouded, sometimes transparent but never truly pellucid in Illinois species; the pronotum various.

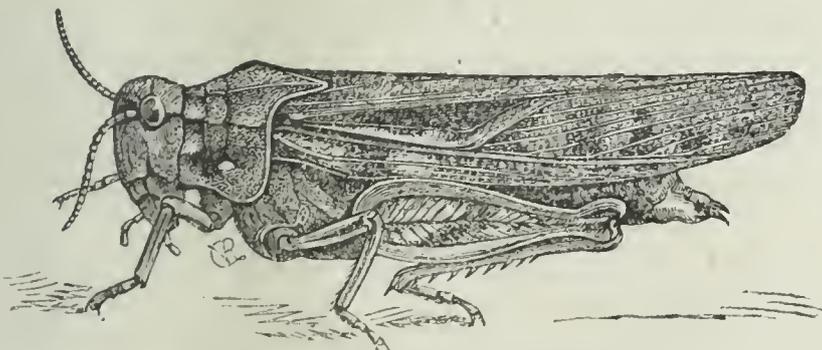
FIG. 13.



Tragocephala viridifasciata.
a. Pupa. b. Perfect insect.

- d. Basal portion of the wings transparent, usually more or less tinged with greenish-yellow; apical portion more or less distinctly clouded with fuscous, but neither crossed or margined by a distinct band; face curved below. Gen. *Tragocephala*.
- dd. Wings variously colored; with a distinct band across them or along the outer margin.
- e. Wings deep yellow or bright red, with a dark band along the outer margin; frontal costa usually more or less distinctly tricarinate above the ocellus; median carina of the pronotum sharp and elevated, sometimes distinctly arched; face curved below. Gen. *Tomonotus*.
- ee. Wings yellow or red, with a dark band across them near the outer border and along the hinder portion of it; median carina of the pronotum minute, or but moderately elevated.
- f. Female large, robust, broad and deep across the thorax; pronotum granulose, or tubercled, rugose; median carina small; lateral carinae generally indistinct on the anterior lobes; vertex foveolate, broad and strongly defined, with a median carina usually visible; wings yellow or red; elytra usually marked with large brown spots; (*phoenicopterus* has the median and lateral carina more prominent, and the foveola of the vertex more elongate, and not quadrate, as most of the other species.) Gen. *Hippiscus*.

FIG. 14.



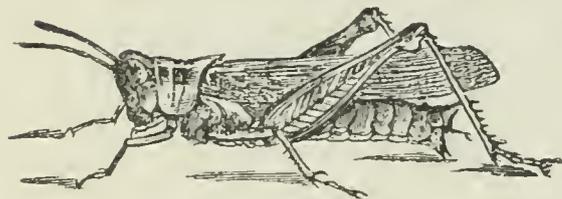
Hippiscus phoenicopterus.

- ff. Female of one species large, then the wings are black, otherwise not robust, or large; pro-

notum not granulose or tuberculate (except in *Mestobregma* where it is somewhat rugose).

- g.* Median carina of the pronotum, prominent, sub-cristate; cut by but one (the posterior) transverse furrow; wings in one species black with a narrow yellowish marginal band, in other species yellow, with a fuscous band across them. Gen. *Oedipoda*.
- gg.* Median carina, small, not prominent, cut in two places.
- h.* Head elevated, eyes standing high; two sub-quadrate black spots on the elytra separated by an oblong whitish spot. Gen. *Mestobregma*.
- hh.* Head not unusually elevated; elytra banded or sprinkled with minute brown dots. Gen. *Trimerotropis*.
- aa.* Prosternum armed with a distinct spine. Group 3. ACRIDINI.
- b.* Elytra and wings always present and always as long or longer than the abdomen.

FIG. 15.



Caloptenus femur-rubrum.

- c.* Abdomen of the male swollen at the tip; eyes round or oval; not elongate-oval. Gen. *Caloptenus*.
- cc.* Abdomen of the male not swollen at the tip; eyes elongate-oval. Gen. *Acridium*.
- bb.* Elytra and wings shorter than the abdomen and sometimes wanting; the abdomen of the male swollen at the tip. Gen. *Pezotettix*.
- II. Pronotum extending back over the entire abdomen, to or beyond its extremity; tarsi without pads between the claws; prosternum in the same plane as the sternum. Sub-fam. TITTIGINÆ.
- A.* Pronotum arched lengthwise. Gen. *Batrachidea*.
- AA.* Pronotum nearly or quite horizontal.
- a.* Antennæ 12 to 14-jointed. Gen. *Tettix*.
- aa.* Antennæ more than 20-jointed. Gen. *Tettigidea*.

Remark.—The foregoing table is intended to include only the Illinois species of *Acrididæ* as far as known; and no attempt is made to set forth generic characters further than what is necessary for this purpose. It is therefore to be considered as entirely artificial, and for the purpose only of assisting those not acquainted with entomology in determining species and as an exercise for classes in natural history in our common schools. I have endeavored to select such characters as are most readily observed, though not always strictly scientific.

KEY TO ILLINOIS SPECIES OF ACRIDIDÆ.

This key is intended as an aid in determining species, without the necessity of determining the genera. The numbers at the right margin following the names in parenthesis, refer to the number of the species given in the list which follows the key. The other figures, in the body of the key, indicate the usual length of the species in inches and decimals of an inch; *m* signifies male and *f* female.

Sub-fam. ACRIDINÆ.

- I. Face distinctly sloped under tower the breast; front of the head projecting before the eyes in the form of a blunt cone or pyramid. Group.—TRUXALINI.
- A. Prosternum armed with a spine; a brown stripe each side. (*M. bivittata.*) 1.
- AA. Prosternum not armed with a spine.
- a. Sides of the pronotum and its lateral carinæ straight and strictly parallel.
- b. Antennæ enlarged and flattened at the base in both sexes; elytra passing the abdomen; pronotum rounded or obtuse-angled behind; female much larger than the male. *f* 1.75; *m* 1.10. (*T. brevicornis.*) 2.
- bb. Antennæ filiform in both sexes; elytra shorter than the abdomen; pronotum truncate behind; length about an inch. (*Chloealtis.*) 3 and 4.
- aa. Lateral carinæ of the pronotum more or less curved or bent inward towards the middle.

- b. Elytra unspotted, pale reddish brown, sometimes shorter and sometimes longer than the abdomen. Length less than one inch. (*St. curtipennis.*) 7.
- bb. Elytra spotted, at least in the female, more or less green, as long or longer than the abdomen.
- c. Spots on the elytra in the form of fuscous serrations, in the female; elytra passing the abdomen; female much larger than the male; length 1.25 to 1.50; male olive-brown and yellowish in stripes; length about one inch; antennae of *f* slightly enlarged and flattened at the base of *m*, enlarged at the tip. *S. admirabilis.* 5.
- cc. Elytra with small dusky spots or dots along the disk; female some larger than the male; length less than an inch. *St. maculipennis.* 6.
- *Elytra more or less greenish.
- †Elytra passing the abdomen. *Var. maculipennis.* }
- ††Elytra about as long as the abdomen. *Var. aequalis.* }
- **Elytra brownish. *Var. propinquans.* }
- II. Face vertical, or nearly so; sometimes curved, as seen from the side, and sometimes slightly sloped under, in the male; prosternum not armed with a spine or tubercle. Group OEDIPODINI.
- A. Wings black, with a narrow yellow border along the outer margin; size large. *Oe. carolina.* 15.
- AA. Wings colored or pellucid; sometimes clouded with fuscous, sometimes with a broad black band across them or around the outer border, but never with the disk or basal portion distinctly black.
- a. Wings pellucid; lateral carinae of the pronotum distinct; median carina slightly prominent, straight on top; elytra marked with brown or fuscous spots; length about an inch. (*C. pellucida.*) 24.
- aa. Wings colored or clouded.
- B. Wings with the basal portion transparent, more or less tinged with greenish yellow; apical portion clouded with fuscous, but not banded.
- c. General color dusky-brown; elytra fuscous-brown, with two more or less complete, paler bands across the middle portion; size medium. (*Tr. sordida.*) 10.
- cc. General color greenish varying to dusky-brown, but elytra never marked with cross-bands; size medium. (*Tr. viridifasciata.*) 9.
- *Elytra striped with green and fuscous. *Var. virginiana.* }
- **Elytra brown. *Var. radiata.* }
- †Elytra ash-brown. *Var. infuscata.* }
- ††Elytra dark brown.
- BB. Wings with a distinct dark band across the outer half, or around the outer border.
- c. Wings with the basal portion distinctly red.

- d. Thorax broad, deep and robust; elytra with large brown or dark spots; wings crossed near the outer border with a broad, dark, curved band; size large; posterior femora very broad; median carina of the pronotum moderately elevated.
- e. Pronotum covered, somewhat regularly, with small tubercles, otherwise nearly or quite smooth; posterior femora deep blue on the inner face. *H. discoideus.* 22.
- ee. Disk of the pronotum more or less distinctly granulated or shagreened; lateral carinae very distinct and nearly continuous; inside of the posterior femora yellowish or pale, but never blue. (*H. phoenicopterus.*) 23.
- DD. Thorax not broad and robust, but somewhat compressed on the sides and rather narrow; median carinae of the pronotum rather prominent; elytra uniform, very dark brown, or ash brown sprinkled over with darker dots; wings bright red, with a broad, black band around the outer border, occupying one-third the area; size medium. (*T. nietanus.*) 12.
- cc. Wings with the basal half yellow or yellowish.
- d. Median carina of the pronotum cristate, and more or less arcuate; wings varying in color from a bright sulphur to a deep orange; with a broad black border; elytra and pronotum varying from ash brown to dark brown; elytra dimly spotted with darker brown; these spots are sometimes nearly or quite obsolete; size rather above medium. (*T. sulphureus.*) 11.
- dd. Median carina of the pronotum only a raised line, or at most but sub-cristate, not uniform, once or twice distinctly severed; wings crossed on the outer half by an arcuate dark band.
- E. Body more than usually robust; thorax, especially of the female, broad and deep; pronotum covered more or less with small tubercles; posterior femora very broad.
- f. Elytra ash brown; spots small somewhat grouped into three indistinct bands; median carina of the pronotum rather slender, usually if not invariably twice notched; size rather above medium. (*H. neglectus.*) 20
- ff. Elytra with large, brownish, irregular spots, not in bands; median carina of the pronotum slender, usually but once severed; size above medium, female large. (*H. corallipes, var rugosus.*) 21
- EE. Body not unusually robust; thorax ordinary or rather slender; pronotum sometimes slightly rugose but not tuberculate or scabrous; posterior femora not unusually broad; size medium.

- f. Median carina of the pronotum cut by but one transverse incision; sub-cristate or at least moderately elevated on the anterior and middle lobes; elytra with three, more or less distinct, bands.
- g. Posterior tibiæ red or reddish; medium size.
- h. General color dark reddish-brown; the notch in the median carina of the pronotum oblique. (*Oe. collaris.*) 14
- hh. General color ash-gray, mottled with dusky brown and white; the notch of the median carina of the pronotum vertical. (*Oe. aequalis.*) 13
- gg. Posterior tibiæ pale yellowish; elytra grayish-brown; dark band of the wings very broad; rather under medium size. (*Oe. belfragii.*) 16
- FF. Median carina of the pronotum small, cut by two transverse incisions; body rather slender; medium size.
- g. Elytra with scarcely any signs of cross bands; almost uniform pale ash-brown, sprinkled over with darker and whitish dots and minute spots; top of the head not more than usually prominent. (*T. maratima.*) 18.
- gg. Elytra with more or less distinct transverse bands; top of the head and eyes standing higher than usual.
- h. Elytra with three tolerably distinct dark bands and two intermediate broad whitish bands; no whitish line along the angle when closed. (*T. verruculata.*) 17.
- hh. Elytra have on the lower field two sub-quadrate black spots, separated by an elongate whitish spot; also a whitish line along the angle when closed. (*M. cincta.*) 19.
- III. Face vertical or nearly so; prosternum armed with a distinct spine. Group ACRIDINI.
- A. Elytra shorter than the abdomen or wanting.
- a. Body robust; resembling a short-winged *Caloptenus bivittatus* in form and color, except that the hind femora are distinctly banded, and the lateral stripes are entirely or partially wanting; elytra meeting on the back, vary from one-third to the full length of the abdomen; lateral carinæ of the pronotum distinct; length of the female usually more than an inch. (*P. viola.*) 28.
- aa. Body rather slender, at least not robust, nor resembling *C. bivittatus*; elytra not meeting on the back, less than, or not more than, half the length of the abdomen in the female; rather small, length less than an inch.
- b. Vertex, especially in the male, unusually narrow between the eyes; pronotum cylindrical; posterior femora greenish; elytra minute, not meeting on the back; face somewhat oblique and arcuate. (*P. minutipennis,*) 26.

- bb.* Vertex of ordinary width, at least not unusually narrow; pronotum scarcely cylindrical; posterior femora not greenish. Similar in form and appearance to *Caloptenus femur-rubrum*; elytra not extending beyond the second segment
(*P. scudderi.*) 27.
- AA.* Elytra as long or longer than the abdomen.
- a.* Elytra without spots, though sometimes striped.
- b.* Without stripes; color of pronotum and elytra nearly or quite uniform, varying from olive green to olive brown; tip of the male abdomen swollen; elytra scarcely longer than the abdomen in the female; rather large. (*C. differentialis.*) 33.
- bb.* A yellow stripe along the middle of the dorsum but none on the sides; color nearly uniform reddish-brown or pale-brown tinged with green; elytra sometimes dimly spotted; tip of male abdomen not swollen; cerci broad and flat.
- c.* Elytra pale reddish-brown with more or less of an olive shade; distinctly longer than the abdomen; sides of the pronotum sparsely sprinkled with yellow dots; median carina of the pronotum simply a minute line, inner face of posterior tibiae black; large; 1.3 to 1.75. (*A. emarginatum.*) 35.
- cc.* Elytra and pronotum, in fact the entire insect, almost uniform reddish-brown; pronotum arched from the sides, forming a prominent median ridge; elytra about as long as the abdomen, medium size. (*A. rubiginosum.*) 34.
- bbb.* A yellow or pale stripe along each side; no stripe along the middle; tip of male abdomen swollen; general color dull olive or olive-brown; size varies from medium to tolerably large. (*C. bivittatus.*) 32.
- AA.* Elytra distinctly spotted, either with large cellular, fuscous spots scattered over them, or a row of quadrate spots along the disk.
- b.* Elytra distinctly passing the abdomen; size large, female two inches or more in length; tip of male abdomen not swollen; elytra marked with large cellular, fuscous spots on the disk and apical portion. (*A. americanum.*) 36.
*Ground color reddish-brown. }
**Ground color yellowish. }
Var. americanum. }
Var. ambiguum. }
- bb.* Elytra usually distinctly passing the abdomen, and sometimes proportionally very long, sometimes but slightly longer in the female; size rather under medium; tip of the male abdomen swollen; spots on the elytra rather small, in a row along the discal area.
- c.* Tip of the sub-anal plate of the male truncate, not notched. (*C. femur-rubrum.*) 29.

- cc. Tip of the sub-anal plate of the male acuminate and notched, notch sometimes minute but never absent.
- d. Essentially and "constitutionally" migratory; a little larger than 29 or 30; wings generally very long. (*C. spretus.*) 31.
- dd. Non-migratory; smallest of the three species; notch in the tip of the sub-anal plate not so distinct as in 31 (*C. atlantis.*) 30.

Remark.—*Stetheophyma lineata* is omitted from this key, because I have no specimen for examination; nor have I attempted to tabulate the *Tettigi*, because of the uncertainty which yet hangs over the specific distinctions. *Pezotettix unicolor* is also omitted.

LIST OF ILLINOIS SPECIES.

This list includes all the species of *Acrididæ* known to me to inhabit the State; it is more than probable that other species have been discovered, if so, it is hoped the publication of this list may bring out that fact. The synonyms are added for the convenience of the readers.

1. *Mermiria bivittata*, Serv.
 Opsomala bivittata, Serv. Hist. Orth. 589.
 Opomala bivittata, Thomas, Syn. Acrid. 64.
 Mermiria belfragii, Stal, Recens. Orth. I. 102.
2. *Truxalis brevicornis*, Linn.
 Gryllus (*Acrida*) *brevicornis*, Linn., Syst. Nat. II. 692.
 Truxalis brevicornis, Fabr. Ent. Syst. II. 27.
 f. *viridulus*, Pal. Beauv. Ins. Orth. 86, Pl. 3, fig. 4.
 m. *notochlorus*, Pal. Beauv. Ins. Orth. 80, Pl. 3, fig. 3.
 Acridium ensicornu, Deg. Ins. III. 499. Pl. 42, fig. 7.
 Opsomala punctipennis, Thos. Trans. Ill. St. Agl. Soc., V. 447.
 Pyrgomorpha brevicornis, Walk. Cat. Dermap. Salt. III. 500.
 Pyrgomorpha punctipennis, Thos. Syn. Acrid. 68.
3. *Chloealtis viridis*, Scudd.
 Chloealtis viridis, Scudd. Bost. Jour. Nat. Hist., VII. 455.
 Opsomala brevipennis, Thos. Trans. Ill. Agl. Soc., V. 451.
 Chrysochraon viridis, Thos. Syn. Acrid. 71.
 Truxalis angusticornis, Stal, Recens. Orthop. I. 105.
4. *Chloealtis conspersa*. Harr.
 Chloealtis conspersa, Harr. Rep. Éd. 1862, 184
 abortiva, Har. Rep. Éd. 1862, 184.
 Stenobothrus melanopleurus, Scudd. Bost. Jour. Nat. Hist.
 VII, 456.
 Chrysochraon conspersum, Thos. Syn. Acrid, 76.

5. *Syrbula admirabilis*, Uhl.
 f. *Stenobothrus admirabilis*, Uhler, Proc. Ent. Soc. Phila.,
 1864, 553.
 m (?) *Oxycoryphus montezuma*, Sauss. Rev. et Mag. Zool,
 1859.
 m (?) *Syrbula leucocerca*, Stal, Recens. Orth. I, 102.
6. *Stenobothrus maculipennis*, Scudd.
 St. maculipennis, Scudd. Bost. Jour. Nat. Hist. VII, 458.
 St. æqualis, Scudd. Bost. Jour. Nat. Hist. VII. 459.
 St. propinquans, Scudd. Bost. Jour. Nat. Hist. VII, 461.
7. *Stenobothrus curtipennis*, Harr.
 Locusta curtipennis, Harr. Cat. Ins. Mass. 56.
 Chloea curtipennis, Harr. Rep. Ed. 1862, 184.
 Stenobothrus lonigpennis, Scudd. Bost. Jour. Nat. Hist. VII, 457.
8. *Stetheophyma lineata*, Scudd.
 Arcyptera lineata, Scudd. Bost. Jour. Nat. Hist. VII, 462.
9. *Tragocephala viridifasciata*, Deg.
 1. *Var. virginiana*.
Acrydium viridifasciatum, DeGeer. Mem. II., 498.
Gryllus (*Locusta*) *viridifasciatus*, Goeze, Beytr I., 115.
Gryllus virginianus, Fabr. Syst. Ent., 291.
Gryllus (*Locusta*) *virginianus*, Goeze, Ent. Beytr, I, 106.
chrysomelus, Gmel, Lynn, Syst, Nat.
 IV, 2086.
Acridium virginianum, Oliv. Encyc. Meth. Ins., vi. 225.
marginatum, Oliv. Encyc., Meth. Ins., vi. 229.
hemipterum, Pal. Beauv. Ins., 145.
Acridium (*Oedipoda*) *virginianum*, DeHaan, Bijdr,
 Kenn. Orth., 143.
Locusta viridifasciata, Harr., Cat. Ins., 56.
Locusta (*Tragocephala*) *viridifasciata*, Harr. Rep., Ed.
 1862, 182.
Gomphocerus viridifasciatus, Uhler, in Harr. Rep.,
 Ed. 1862, 181.
Oedipoda virginiana, Burm. Handb. Ent., I. 645.
Tragocephala viridifasciata, Scudd. Bost. Jour. Nat.
 Hist., vii, 461.
2. *Var. radiata*.
Locusta radiata, Harr. Cat. 56.
Tragocephala radiata, Harr. Rep., Ed. 1862, 183.
Gomphocerus radiatus, Uhl. Harr. Rep., Ed. 1862, 181.
3. *Var. infuscata*.
Locusta (*Tragocephala*) *infuscata*, Harr. Rep. Ed.
 1862, 181
Gomphocerus infuscatus, Uhl. Harr. Rep., Ed. 1862, 181.
Tragocephala infuscata, Scudd. Bost. Jour. Nat. Hist.,
 vii. 466.
10. *Tragocephala sordida*, Burm.
Oedipoda sordida, Burm. Handb. Ent. II. 643.
Acridium (*Oedipoda*) *sordidum*, DeHaan, Bijdr. Kenn.
 Orth. 143.
Locusta nebulosa, Erichs. Archiv. f. Nat. II. 230.
Locusta periscelidis, Harr. Cat. 56.
Tragocephala sordida, Stal, Recens. Orth. I. 119.

Encoptolophus sordidus, Scudd. Proc. Bost. Soc. Nat. Hist. XVII.

11. *Tomonotus sulphureus*, Fabr.
 1. *Var. sulphureus*.
Gryllus sulphureus, Fabr. Syst. Ent. II. 59.
Gryllus (Locusta) sulphureus, Gmel. Linn. Syst. Nat. I. 2079.
Acridium sulphureum, Oliv. Encyc. Meth. Ins. VI. 227.
Oedipoda sulphurea, Burm. Handb. Ent. II. 643.
Locusta sulphurea, Harr. Rep. Ed. 1892, 177.
Tomonotus sulphureus, Sauss., Rev. et Mag. Zool. XIII. 321.
Arphia sulphurea, Stal, Recens. Orth. I. 119.
 2. *Var. xanthopterus*.
Oedipoda xanthoptera, Burm. Hand. Ent. II. 643.
Acridium xanthopterum, De Haan, Bijdr. Kenn. Orth. 143.
Tomonotus xanthopterus, Thos. Syn. Acrid. 105.
Arphia xanthoptera, Scudd. Geol. Surv. N. H. I. 377.
 3. *Var. carinatus*.
Oedipoda carinata, Scudd. Trans. Am. Ent. Soc. II. 306
Tomonotus carinatus, Thos. Syn. Acrid. 106.
12. *Tomonotus nietanus*, Sauss.
Oedipoda tenebrosa, Scudd. Hayden's Geol. Surv. Neb. 251.
Tomonotus pseudo-nietanus, Thos. Proc. Acad. Nat. Sci. Phila. 1870-80.
tenebrosus, Thos. Syn. Acrid. 107.
Arphia sanguinaria, Stal, Recen. Orth. I. 119.
Tomonotus nietanus, Sauss. Mag. de Zool. 1859.
13. *Oedipoda aequalis*, Say.
Gryllus aequalis, Say. Jour. Acad. Nat. Sci. Phila. iv. 307.
Locusta aequalis, Harr. Rep. 583.
Oedipoda aequalis, Erichs. Archiv. f. Nat. ix. 230.
Trimerotropis aequalis, Scudd. Geol. Surv. N. Hamp. i. 377.
Spharangemon aequale, Scudd. Proc. Bost. Soc. Nat. Hist. XVII.
14. *Oedipoda collaris*, Scudd.
Oedipoda collaris, Scudd. Geol. Surv. Neb. 250.
Spharangemon collare, Scudd. Proc. Bost. Soc. Nat. Hist. XVII.
15. *Oedipoda carolina*, Linn.
Gryllus (Locusta) carolinus, Linn. Syst. Nat. I. 701.
Gryllus carolinus, Fabr. Ent. Syst. II. 58.
Acrydium carolinum, Deg. Inst. III. 491
Locusta carolina, Harr. Rep. 176.
caroliniana, Catsb. Nat. Hist. Car. II. 89.
Oedipoda carolina, Burm. Handb. Ent. II. 643.
Acridium carolinianum, Pal. Beauv. Ins. 147.
16. *Oedipoda belfragii*, Stal.
Oedipoda belfragii, Stal, Recens. Orth. I. 129.

17. *Trimerotropis verruculata*, Kirb.
Locusta verruculata, Kirby, Faun. Bor. Am. Ins. 250.
latipennis, Harr. Rep. 179.
Acridium verruculatum, DeHaan, Bijdr. Kenn. Orth. 250.
Oedipoda latipennis, Uhler, Harr. Rep., 178.
Trimerotropis verruculata, Scudd. Geol. Surv., N. Hamp.
 I, 377.
18. *Trimerotropis maratima*, Harr.
Locusta maratima, Harr. Rep. 178.
Oedipoda maratima, Uhler, Harr. Rep. 178.
Trimerotropis maratima, Stal, Recens. Orth. I, 135.
19. *Mestobregma cincta*, Thos.
Oedipoda cincta, Thos. Proe. Acad. Nat. Sci. Phila.
 1870, 80.
20. *Hippiscus neglectus*, Thos.
Oedipoda neglecta, Thos. Proc. Acad. Nat. Sci. Phila.
 1870, 84.
Hippiscus neglectus, Scudd. Bull. Geol. Surv. Terr. Vol.
 II, No. 3, 264.
21. *Hippiscus corallipes*, Hald. var. *rugosus*.
Oedipoda rugosa, Scudd. Bost. Jour. Nat. Hist. VII, 469.
Hippiscus rugosus, Scudd, Geol. Surv., N. Hamp. I, 377.
22. *Hippiscus discoideus*, Serv.
Oedipoda discoidea, Serv. Hist. Orth., 724.
Acridium tuberculatum, Pal. Beauv. Ins. 145.
Hippiscus discoideus, Stal, Recens. Orth. I. 121.
23. *Hippiscus phænicopterus*, Germ.
Locusta apiculata, Harr. Cat. 56.
corallina, Harr. Rep. 176.
Acridium phænicopterum, DeHaan, Bijdr. Kenn. Orth.
 144.
Oedipoda phænicoptera, Germ. Burm. Handb. Ent. II.
 643.
corallina, Erichs. Archiv, f. Nat. ix 229.
Hippiscus phænicopterus, Scudd. Geol. Surv. N. Hamp.
 I. 377.
24. *Camnula pellucida*, Scudd.
Oedipoda pellucida, Scudd. Bost. Jour. Nat. Hist.
atrox, Scudd. Geol. Surv. Neb. 253.
Camnula tricarinata, Stal, Recens. Orth. I. 120.
pellucida, Scudd. Geol. Surv. N. Hamp. I. 378.
25. *Pezotettix unicolor*, Thos.
Pezotettix unicolor, Thos. Synop. Acrid. 151.
26. *Pezotettix minutipennis*, Thos.
Pez. minutipennis, Thos. Bull. I. Ill. Museum 66.
27. *Pezotettix scudderi*, Uhl.
Pez. scudderi, Uhler, Prac. Ent. Soc., Phila. II. 555.
28. *Pezotettix viola*, Thos.
Pez. viola, Thos. Bull. I. Ill. Museum 68.
29. *Caloptenus femur-rubrum*, Deg.
Acrydium femur-rubrum, Deg. Ins. III. 498.
femorale, Oliv. Encyc. Meth. Ins. VI. 228.
Gryllus (Locusta) erythropterus, Gmel. Linn. Syst. Nat.

- I. 2,086.
 Caloptenus femur-rubrum, Burm. Handb. Ent. II. 638.
 Melanoplus femur-rubrum, Stal, Recens. Orth. I. 79.
30. *Caloptenus atlantis*, Riley.
 Cal. atlantis, Riley, 1st Rep. 1875, 169.
31. *Caloptenus spretus*, Thos.
 Cal. spretus, Thos. Synop. Acrid. 164.
32. *Caloptenus bivittatus*, Say.
 Gryllus bivittatus, Say, Jour. Acad. Nat. Sci., Phila. IV.
 308.
 Locusta leucostoma, Kirby, Faun. Bor. Am. Ins. 250.
 Acridium sanguinipes, Harr. Hitch. Rep. 583.
 flavovittatum, Harr. Rep. 173.
 bivittatum, Thos. Trans. Ill. Agl. Soc. V. 449.
 Caloptenus femoratus, Burm. Handb. Ent. II. 368.
 bivittatus, Uhl. Say's Ent. ed. Lec. II. 238.
33. *Caloptenus differentialis*, Thos.
 Acridium differentiale, Thos. Trans. Ill. Agl. Soc., V.
 450.
 Cyrtacanthacris differentialis, Walk. Cat. Dermap. Salt.
 IV. 610.
 Caloptenus differentialis, Thos. Proc. Acad. Nat. Sci.,
 Phila., 1871.
34. *Acridium rubiginosum*, Scudd.
 Acrid. rubiginosum, Scudd. Bost. Jour. Nat. Hist. VII.
 467.
 damnificum, Sauss. Rev. et Mag. Zool. XIII., 164.
35. *Acridium emarginatum*, Scudd.
 Acrid. emarginatum, Scudd. Geol. Surv. Neb. 240.
36. *Acridium americanum*, Drury.
 Gryllus americanus, Drury, Illust. II., 3, 128.
 succinctus, Linn. Syst. Nat. 11th ed. I. 699.
 serialis, Thunb. Mem. Acad. St. Pet. V. 241.
 Locusta tartarica, West. Dru. Ill. I. 121.
 Acridium americanum, Scudd. Bost. Jour. Nat. Hist.
 VII. 466.
 rusticum, Glov. Ill. pl. i. fig. 15.
 Cyrtacanthacris americana, Walk. Cat. Deramp. Salt.
 III. 550.
 Schistocerca americana, Stal, Recens. Orth. I. 66.
 Var. *ambiguum*, Thos.
 Acridium ambiguum, Thos. Synop. Acrid. 173.
37. *Tettix ornata*, Say.
 Acrydium ornatum, Say, Am. Ent. I. 10.
38. *Tettigidea lateralis*, Say.
 Acrydium laterale, Say, Am. Ent. pl. v. figs. 2 and 3.
39. *Tettigidea polymorpha*, Burm.
 Tetrax polymorpha, Burm. Handb. Ent. II. 659.

DESCRIPTION OF SPECIES.

1. MERMIRIA BIVITTATA. Serv.

Female.—Face tricarinate, very oblique, carinæ prominent; the median sulcate but scarcely double. Vertex rather short, round, and slightly margined in front; scarcely as long as broad. Promotum slightly contracted in the middle, lateral carinæ indistinct, median distinct. Prosternal point short, tuberculiform. Elytra and wings passing the abdomen.

Color.—Yellowish-green; often tinged with reddish-brown. Behind each eye starts a dark brown or black stripe, which reaches the posterior border of the pronotum and extends upon the elytra. Elytra opaque from the base to the middle, transparent beyond, tinged with brown; the first half of the internal margin has a longitudinal greenish stripe, and a similar stripe near the anterior margin, but not reaching quite half the length of the elytra. Wings transparent; nerves and nervules of the apical half dark. Legs greenish; the femora striped above with reddish-brown.

Male.—Similar, but smaller.

Dimensions.—Length to tip of elytra, 1.50 to 1.65 inches; posterior femora 1 inch; posterior tibiæ 0.95 inch; elytra 1.08 inches.

I am not certain that this species has been observed in Illinois, but think I have seen one specimen taken in the state.

2. TRUXALIS BREVICORNIS. Linn.

Female.—Pale green, somewhat dotted over with brown; sometimes the back is ash-brown and sometimes this color prevails throughout. Top of the head slightly ascending; vertex projecting, horizontal,

rounded in front; no lateral foveolæ; the advance in front of the eyes not quite equal to the length of the eye; a very slight median carina. Face quite oblique; seen from the side curves slightly inward below the vertex; regularly widening from the apex of the eyes downward, rounded transversely; the carinæ generally slight and obtuse, but sometimes slightly prominent; frontal costa slightly prominent between the antennæ, but not prominent below, gradually expanding below, more or less sulcate; lateral carinæ more or less distinct, nearly straight, reaching the corners of the face. Antennæ about as long as the head and pronotum, enlarged and flattened at the base, acuminate at the apex, triquetrous. Eyes oblong-ovate, oblique, and placed well forward near the antennæ. Pronotum a little longer than the head, truncate in front; hind border very obtusely angled; sides flat, perpendicular, straight and very nearly or quite parallel; tricarinate, the three carinæ about equal, distinct but not prominent, straight, parallel; posterior transverse incision situated a little behind the middle, bends forward in the middle, and cuts the median carina; the two anterior incisions sub-obsolete; the posterior margin of the side somewhat regularly though slightly curved inward, the lower posterior angle being sub-acute. Elytra and wings pass the posterior femora, and are about as long as the abdomen; the former are narrow and obliquely truncate at the apex. Abdomen sub-cylindrical, elongate, slightly enlarged at the apex; the upper valves of the ovipositor unusually long and exserted. Posterior femora shorter than the abdomen, not reaching the extremity of the elytra, slender, being but slightly enlarged at the base.

General color as given above. Antennæ and generally the front legs in all the varieties pale reddish brown; the lateral carinæ brown; the eyes and a spot below them brown. The elytra with a few fuscous or dark dots along the disk; wings pellucid or slightly tinged with yellowish at the base; nerves of the anterior portion roseate in the green variety; somewhat dusky in the brown specimens. Length, 1.50 to 1.75; elytra, 1.10 to 1.25 inches.

Male.—Similar to female, except that it is very much smaller, rather more compressed on the sides, head slightly more ascending, face slightly more oblique, vertex rather more acute. The back is usually green; the sides in all cases so far as I have observed, entirely and uniformly fuscous, without spots or stripes. Length, 1.00 to 1.15; elytra, .80 to .90 inches.

This species, so far as I am aware, has been found only at one point in this State, and that a very limited area near Murphysboro, Jackson county.

It is fond of damp, swampy places covered with a rich growth of grass, not too heavily swarded. As it is found south as far as the West Indies, it is probable Jackson county is the extreme northern limit of its district.

3. CHLOEALTIS VIRIDIS. Scudd.

Vertex broad, slightly expanding in front of the eyes, beyond which the sides converge so as to form a right angle, rounded at the apex; the edge more or less upturned, so as to form a lunar or semicircular depression behind it; frontal costa scarcely sulcate above the ocellus in the female, sub-sulcate in the male. Pronotum with the sides compressed, vertical, parallel; the three carinæ distinct, equal, parallel; the transverse impressions indistinct, the posterior much behind the middle. Elytra ovate-lanceolate, about half as long as the abdomen in the female, three-fourths its length in the male. Sub-anal plate of the male turned up, somewhat pointed, entire at the tip. Posterior femora in the female about as long as the abdomen.

Color.—Of the male; whole of the upper surface green; sides a dirty brown, sometimes with a black streak extending back from the eye. Front of the head yellowish-brown or yellow. Front and middle legs greenish, tinged with reddish-brown; posterior femora greenish-yellow; tibiæ fuscous, spines tipped with black. Female varies in color from almost entirely pale-green to dark-brown, with a dark stripe running back from each eye along the upper margin of the sides of the pronotum; disk of the elytra marked with two or three fuscous dots; hind tibiæ reddish-brown.

Dimensions.—*f.* Length, 1 inch; pronotum, 0.21 inch; hind femora, 0.6 inch; elytra, 0.42 inch. *m.*—Length, 0.6 inch; pronotum, 0.14 inch; hind femora, 0.4 inch; elytra, 0.3 inch.

This and the following species are placed in the genus *Chrysochraon* in my "Synopsis of the Acrididæ." Found throughout the State, and, although not abundant, is quite common.

4. CHLOEALTIS CONSPERSA. Harr.

Vertex broad, expanded to a blunt point on each side in front of the eyes, from which the sides converge so as to form little less than a right angle, blunt at the tip; edges a little upturned; a very slight median carina; frontal costa with a shallow sulcus two-thirds its length. Eyes not large or prominent, slightly elongated. Antennæ slender, slightly flattened, reaching to the middle of the elytra in the male. Pronotum with the sides nearly straight, or slightly converging in the middle; median carina sharp, rather more distinct than the lateral; front and posterior margins straight. Elytra in the male, reaching nearly to the tip of the abdomen, obovate-lanceolate, suddenly swollen on the costal border about two-thirds of the way from the apex to the base, internal border full and curved evenly from the base to the tip; in the female the elytra reach about the middle of the abdomen.

Color.—Male: head above, dorsum of the pronotum, sides of the meso and meta-thorax, the face and sides of the head below the eyes, and the elytra a light lilac-brown, varying in intensity in different specimens; sides of the head behind the eyes shaded with black. Antennæ dark-brown, darkest at the tips. Sides of the pronotum and of the first two or three abdominal segments shining black. Abdomen light-brown above, banded with black; light yellow beneath; sides, except on the first two or three segments, dark reddish-brown. Fore and middle legs brown; hind femora light yellowish-brown above, with one or two broad dark brown bands, light-yellow below, apex black; hind tibiæ yellowish-red, black at the base and tips.

The female differs from the male in being darker, and in wanting most of the black on the sides of the pronotum. Head, dorsum of the pronotum, and elytra frequently mottled or even blotched with dark-brown; sides of the pronotum like the dorsum, except a small patch of black on the upper posterior angle.

Dimensions.—*f*—Length 0.8 to 0.9 inch; elytra 0.30 to 0.37 inch; hind femora 0.50 to 0.55 inch. *m*—Length 0.65 to 0.70 inch; elytra 0.35 to 0.40 inch; hind femora 0.40 to 0.45 inch.

Found throughout the State, but I believe is nowhere common.

5. SYRBULA ADMIRABILIS. Uhl.

Female.—Large size; lateral foveolæ of the vertex wanting; elytra and wings as long as the abdomen; general color green, striped with fuscous and carneous.

Vertex prominent, not expanding in front of the eyes; margins slightly elevated, obtuse; no middle foveola; but a slight depression each side within the margins, which are separated by a dim median carina, that extends back across the occiput. Face straight, very oblique, quadricarinate; the carinæ straight, diverging below and reaching the clypeus. Eyes, pyriform, oblique, pointed at the apex. Antennæ somewhat flattened and often slightly enlarged near the base. Pronotum about as long as the head, contracted slightly in the middle; the three carinæ distinct, cut a little behind the middle by a cross incision, the lateral curving inward slightly on the anterior lobe. Elytra, wings and posterior femora passing the abdomen.

Color.—Face and sides of the head green; antennæ and palpi carneous; eyes brownish; a pale reddish-brown or carneous stripe reaches from the vertex to the hind border of the pronotum, bordered each side by a dark fuscous stripe. Sides of the pronotum green, with a fuscous stripe along the middle; the posterior lobe punctured on the sides. Middle field and upper margin of the elytra green; the green of the middle serrated above by the notches of the fuscous portion, which occupies the upper (posterior) half; lower (anterior) margin fuscous.

Wings transparent, tinged with greenish-yellow at the base; nerves dusky; apex slightly fuliginous. The upper half of the disk of the posterior femora green, lower half yellowish or reddish; posterior tibiae pale at base, apical portion dusky; spines yellowish tipped with black. Alcohol changes the green and carneous to a pale dull yellow; otherwise the markings remain unchanged, except that they are somewhat faded.

Male.—Head above, slightly ascending to the vertex, giving to the whole head an upward bend; front conical; face much sloped. Vertex without lateral foveolae; margins slightly raised, with two inclosed depressions separated by a slight median ridge, which runs forward to the fastigium. Frontal costa quite broad and flat, very slightly sulcate below the ocellus, margins angled; lateral carinae distinct; the face is sloped backward toward the breast so much that the angle it forms with the upper surface is less than forty-five degrees. The pronotum is short, scarcely exceeding the length of the head; sides compressed, nearly parallel, expanding very slightly posteriorly; tricarinate; the carinae about equal, being simply raised lines, very nearly parallel, severed once by the minute posterior sulcus a little behind the middle; front margin sub-truncate; posterior margin sub-truncate, rounded; the lateral margins descending almost straight to the lower angle. Elytra and wings passing the abdomen slightly, narrow. The sub-anal plate is prolonged in the form of a short, blunt ovipositor. Antennae somewhat clavate, the club commencing with the twelfth or thirteenth joint. Eyes very oblique, elongate-ovate, pointed above.

Color.—Yellowish-brown in stripes. Face yellowish, the corners of the mouth piceous. A narrow yellow stripe runs back from each eye to the pronotum, bordered on each side with light brown, the upper fading on the upper edge to yellowish; a pale brownish stripe along the middle of the occiput. Antennae pale at base; club black on one side and pale on the other. Carinae of the pronotum yellow, the inter-spaces of the disk brownish; the posterior lobe on the sides marked with black punctures and minute, angular, yellow raised lines; some yellow stripes on the sides. Elytra transparent, somewhat fuliginous, with a dusky spot or two on the disk near the base.

Wings transparent and almost uniformly fuliginous, though not clouded. Posterior femora yellowish, with two or three oblique dusky bands on the upper portion of the exterior face; apex black.

Posterior tibiae with knee black; a broad white ring just below the knee; rest dusky, but the upper (posterior) side shows minute abbreviated alternate rings of black and white; the base of the spines white, tips black. Tarsi a dusky yellow.

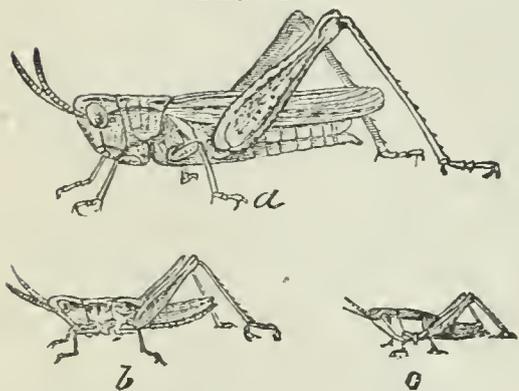
Dimensions.—*f*—Length, 1.3 inches; pronotum, 0.23 inch; elytra, 1 inch; posterior femora, 0.86 inch; posterior tibiae, 0.77 inch. *m*—Length, 1 inch; elytra, 0.75 inch; posterior femora, 0.65 inch; posterior tibiae, 0.62 inch; pronotum, 0.13 inch.

This fine species is found throughout the state, but is not very common. I am not *absolutely* certain that the insect described as the male, is the male of this species, as I have not taken them *in copulo*, but after studying the species for some ten or twelve years feel justified from facts observed in assuming that it is. I find the two in the same situations at the same time and nothing to answer for the male of the one and the female of the other, if these be not the two sexes of the same species.

I am now quite well satisfied that Saussure's *Oxycoryphus montezuma* and Stal's *Syrbula leucocerca* are the same species and the male of this species. If I am correct in this conclusion, then the true name of the species will be *Syrbula montezuma* Sauss. as his species was described in 1861, in the *Revue et Magasin de Zoologie*. Uhler's description of *St. admirabilis* was first published in the proceedings of the Entomological Society of Philadelphia in 1864; and Stal's description of *S. leucocerca* in his *Recensio Orthopterorum* Pt. I in 1873. As Stal's genus *Syrbula* appears to have been founded on the males of the two supposed species, *Ox. montezuma* and *S. leucocerca*, it will need some modification so as to include the female. As neither the male or female appears to belong properly to *Stenobothrus*, but both approach nearer to *Syrbula* than any other genus, the male evidently belonging there, I have included the species in the latter genus. The antennæ of the female instead of being slightly enlarged at the tip, as in the male and as Stal's generic description requires, is really slightly enlarged and flattened at the base, and narrowed toward the apex.

6. STENOBOTHRUS MACULIPENNIS. Scudd.

FIG. 16.



Stenobothrus maculipennis.
a. Perfect insect. b. Pupa.
c. Larva.

Vertex with the margins raised, the sides very slightly expanded in front of the eyes; apex blunt; lateral foveolæ, when present very shallow and broader toward the eyes than at the apex, but these are often obliterated by the absence of their lower margin. Face oblique, nearly straight, frontal costa somewhat prominent, sides parallel, or nearly so, until near the clypeus, where it expands and fades, sometimes sulcate, at others scarcely sulcate; lateral carinæ distinct. Pronotum slightly constricted about

the middle; the three carinæ rather slight, the lateral converging at the middle, nearly parallel on front lobe, diverging on the posterior lobe; hind border obtusely rounded. Elytra and wings passing the abdomen.

Color.—Head and disk of the pronotum green, (in some individuals brown); a reddish-brown broad band behind the eyes reaches to the hind edge of the pronotum, limited above by the lateral carinæ, which are white, but partially crossing these near the hind border; sides of the pronotum below the band brownish or dull yellowish. Elytra green, with a median band of equidistant, square black spots along its whole extent, besides a few irregularly-scattered smaller black spots; sometimes the inner halves of the area entirely of a rust-red color. Legs yellowish-brown; the hind femora sometimes streaked with red

or brown; hind tibiæ plumbeous. Antennæ reddish at base; rest brown or fuscous.

Dimensions.—*f*—Length, 0.75 inch; antennæ 0.26 to 0.35 inch; hind femora, 0.45 inch; elytra, 0.7 inch. *m*—Length, 0.45 to 0.55 inch.

Var. æqualis.—Very similar in appearance to *St. maculipennis* but smaller, with elytra extending only to the tip of the abdomen. Vertex broad and blunt, the sides slightly swollen at the anterior border of the eyes; apex blunt, and all the angles rounded; the edge slightly but not sharply upturned; foveolæ shallow, short, and nearly equiangular. Lateral carinæ of the pronotum curved inward a little in the middle, not so prominent as the sharp median carina; hind border slightly angular, but nearly straight. Elytra and wings just reaching the extremity of the abdomen.

Color.—Much the same as *St. maculipennis*. The lateral carinæ of the pronotum are yellow, and the stripe extends to the eye; the stripe behind the eye is quite narrow, and the sides below it green, like the parts above, and the triangular dash of black upon the top of the pronotum at the hinder angles is much narrower than there, on account of the lesser divergence of the lateral carinæ. The median stripe of the elytra containing the square black dots is yellowish-brown as in *St. maculipennis* and the extremity is extremely pellucid.

Dimensions.—*m*—Length 0.45 inch; antennæ 0.24 inch; hind femora 0.3 inch; elytra 0.34 inch. *f*—Length 0.66 inch; antennæ 0.2 inch; hind femora 0.38 inch; elytra 0.46 inch.

Var. propinquans.—Very similar to *St. bilineatus*, but of larger size and has proportionally longer wings. It is also closely allied to *St. maculipennis*. Vertex broad, expanding but slightly at the anterior border of the eyes; the angle rounded, the apex blunt; edges scarcely, if at all, raised; foveolæ as in *St. maculipennis* but shallower. Lateral carinæ of the pronotum somewhat convergent in the middle, of equal prominence and sharpness as the median; hind border of the pronotum somewhat rounded. Elytra and wings a little longer than the abdomen.

Color.—Brown. A dark stripe behind the eye quite broad; lateral carinæ yellowish; a faint, curved dark stripe from the inner border of the eyes to the lateral carinæ. Antennæ yellowish-brown. Elytra brownish at the base, transparent at the apex, with a middle line of brown spots extending two-thirds of the distance toward the tip. Legs yellowish brown; hind tibiæ plumbeous, with a broad pale annulation at the base.

Dimensions.—*m*—Length 0.6 inch; antennæ 0.26 inch; hind femora 0.38 inch; elytra 0.55 inch. *f*—Length 0.75 inch; antennæ 0.23 inch; hind femora 0.48 inch; elytra 0.68 inch.

This species is readily distinguished from other Illinois species by the oblique face, filiform antennæ, spots on the elytra and small size.

It and probably the varieties are found in the northern and central portions of the State; how far south the limits of its district extend has not been positively ascertained.

7. STENOBOTHRUS CURTIPENNIS. Harr.

Vertex expanding on each side immediately in front of the eyes, into an angular point a little more obtuse than a right-angle; margins raised, obtuse, converging in front to a right-angle; apex blunt; lateral foveolæ distinct, linear. Face oblique, that of the male more so than that of the female, slightly arcuate; frontal costa very prominent, sides nearly parallel, flat or sub-convex above the ocellus, rest sulcate; lateral carinae curving regularly from the inner margin of the eyes to the corners of the face. Antennae passing the thorax, especially in the male; thick, somewhat flattened, and slightly enlarged toward the apex; joints more contracted in the male. Sides of the pronotum somewhat compressed, especially on the lower posterior portion, giving to this part the appearance of being slightly indented and contracted, nearly parallel, but slightly widest in front; the three carinae distinct, equal, the lateral approximating in advance of the middle, about one-third the distance from the anterior border; slightly divergent from this point to the front border, more divergent posteriorly; the three are cut by the posterior incision a little behind the middle; posterior extremity obtusely rounded. Elytra and wings narrow, sometimes shorter than, and sometimes passing the abdomen. Valves of the ovipositor rather longer and more exerted than usual.

Color.—Head and thorax brown; a broad, shining black stripe on the side, behind the eye, extending to the posterior extremity of the pronotum along the upper margin, a portion of it extending above the lateral carina at the hind extremity; sometimes there is a longitudinal dark streak on the top of the head. Antennae yellowish-brown at the base, the rest brown or black. Elytra uniform pale reddish-brown; wings pellucid. Hind femora pale-brown or yellowish, except at the apex, which is black; hind tibiae black at the knee, rest pale red or yellow. Under side dull-yellow.

Dimensions.—*f*—Length 0.75 to 0.84 inch, antennae 0.27 to 0.30 inch; elytra 0.36 to 0.66 inch; hind femora 0.47 to 0.50 inch. *m*—Length 0.55 to 0.65 inch; antennae 0.35 to 0.37 inch; elytra 0.40 to 0.60 inch; hind femora 0.42 to 0.44 inch.

8. STETHEOPHYMA LINEATA. Scudd.

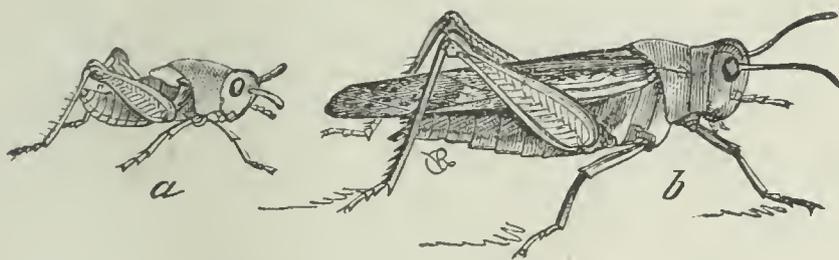
Vertex of the head broad, slightly swollen at the front border of the eyes; apex docked; edge raised to a ridge, with a median ridge extending over the whole top of the head; foveolæ small, shallow, triangular. Pronotum rugose; lateral carinae parallel on the anterior half, somewhat divergent behind, not so high as the median, and much broken. Elytra long and slender, with no swollen curves; the costal border not so prominent near the base as is usual in this genus.

Color.—Dark-brown. A narrow, curved, dark line, extends from the upper border of the eyes to the lateral carinæ of the pronotum, and is the inner limit of a broad, brownish-yellow band, which extends from the eye to the lateral carinæ, whence it continues backward along the carinæ; below this, upon the upper border of the side extends another broad, black band from the eye to the hind edge of the pronotum; the median carina is black. The elytra have the costal edge dark, beneath which is a yellow streak extending from the base to the costal border at about two-thirds the distance to the apex; beneath this is a band, narrow and black at base, broadening till it occupies the whole width of the elytra, becoming brown toward the tip, while the inner border is yellowish-brown. The wings dusky, the internal half with a yellowish tinge. Legs dark-brown; hind femora black on the outer and inner surfaces, reddish-brown above, coral-red below, with a white spot near the apex; tip black. Hind tibiæ yellow, with black spines; the base and tips black, and a dusky annulation below the knee.

Dimensions.—*m*—Length, 1 inch. *f*—Length, 1.4 inch; elytra 1.12 inch; hind femora 0.72 inch.

9. TRAGOCEPHALA VIRIDIFASCIATA. Hannan.

FIG. 17.



Tragocephala viridifasciata.
a. Pupa. b. Perfect insect.

Var. virginiana.—Vertex triangular, acuminate in front, blunt at the tip, not deflexed; margins slightly elevated though sometimes obliterated in the female, to which this description chiefly applies; lateral fovealæ very shallow, flat or obsolete, triangular, the apex forward. Frontal costa prominent; sides nearly parallel; solid and slightly arcuate above the ocellus, punctured; sulcate below in the males, and dimly sulcate in the females; the margins obtuse; lateral carinae slightly prominent, curving outward. Pronotum with the median carina prominent, continuous, and in the female sometimes slightly arched; a dim transverse incision in front of the middle is visible in some specimens; lateral carinæ obliterated in front, somewhat apparent on the posterior lobe; front margin extending on the occiput in an obtuse angle; posterior extremity acute-angled. Elytra and wings pass the abdomen, former obliquely sub-truncate at the apex. Upper carina of the poste-

rior femora somewhat elevated near the base; posterior tibiæ deeply channeled exteriorly. Antennæ short, robust; enlarged slightly and somewhat flattened at the apex. Sub-anal plate of the male tumid, ending in a blunt point, entire, hairy; cerci prominent, somewhat flattened, longer than the triangular supra-anal plate.

Color.—Head, thorax, exterior face of the posterior femora, and a broad stripe along the lower margin of the elytra, grass-green or yellowish-green. Parts of the mouth, antennæ, entire under surface and the four anterior legs usually a distinct and shining reddish brown. The upper or posterior area of the elytra ash-brown, a stripe of the same color along the lower or costal margin; the green of the elytra suddenly decreases a little behind the middle, the apical third being chiefly brownish; the relative proportion of these stripes vary considerably in different individuals. Wings transparent yellow at the base; the apical two-thirds fuliginous or clouded; paler at the apex. Posterior tibiæ with a white ring near the knee, rest pale reddish or blue; tarsi reddish.

Var radiata.—Head and thorax ash-brown, streaked and spotted with black and dark-brown. Elytra brown, where in *virginiana* they are green; anterior or costal margin near the base pale. Exterior face of the posterior femora cinereous; posterior tibiæ dark-blue below the pale ring. Males much smaller and darker.

Var. infuscata.—Male. Head and thorax narrow and compressed at the sides. Vertex strongly advanced in front of the eyes, acute-angled; margins elevated, sharp; lateral foveolæ almost obsolete. Frontal costa very prominent, narrow; the portion above the ocellus arcuate, solid; slightly narrowed at the ocellus and sulcate. Joints of the antennæ much shortened and sub-distinct. Median carina of the pronotum somewhat prominent, sharp, straight on top and entire; lateral carinæ sub-acute but not elevated.

Both sexes dusky brown; elytra faintly spotted with brown; wings as in *virginiana* except that there is often a more distinct cloud near the outer border, but this is also occasionally seen in the former. Posterior femora pale, with two large black spots on the inside; posterior tibiæ brown, with darker spines. This is distinctly smaller than either of the other varieties, and the notes of the male much sharper.

I have some reasons for believing that the males of this species are generally of this variety, at least so far as my observations have extended, I find the females of the other varieties very largely in excess of the males, and precisely the reverse in reference to this variety.

Dimensions.—Length of female 1.0 to 1.3 inches; male from .6 to 1.0 inch.

This is one of our most common species throughout the State, although never appearing in such numbers as some species of *Culoptenus*. The larvæ and pupæ and even the perfect insects are occasionally observed during warm days in winter. It appears early in the spring and continues throughout the summer. The males, especially of the variety *infuscata* are easily detected in the warm days of spring and early summer by their sharp clicking notes.

10. TRAGOCEPHALA SORDIDA. Burm.

Form of the head and pronotum much as in *Tomonotus nietanus*. Central foveola of the vertex broad, slightly transverse in the female, triangular and closed in front, median carina sub-distinct; lateral foveolæ shallow, slightly enlarged, elongate-triangular, indistinct in the male; frontal costa prominent, narrow, sulcate, obliterated before reaching the clypeus; face seen from the side arcuate. Median carina of the pronotum prominent, subcristate, severed about the middle and slightly notched, anterior portion in the female arcuate, both parts somewhat arcuate in the male; lateral carinæ sub-distinct on the front and posterior lobes; anterior margin slightly angled, and extending slightly upon the occiput; apex right-angled. Elytra and wings passing the abdomen; wings rather narrow. Antennæ short, somewhat flattened, and slightly enlarged at the apex.

General color dusky brown, varied with lighter and darker shades. Head and thorax varied with patches of lighter and darker shades. Elytra fuscous, with two pale fasciæ on the middle portion, sometimes only crossing the lower half, at others crossing the entire width. Wings transparent-yellow on the inner half; apical half fuliginous or smoky; front margin dusky. Posterior femora indistinctly banded with yellowish and brown; posterior tibiae dusky-brown, with paler ring near the knee. Antennæ pale at the base, fuscous at the apex.

Female—Length 1.2 to 1.25 inches; male, .9 to 1 inch.

Found throughout the State, but not common.

11. TOMONOTUS SULPHUREUS. Fabr.

Var. sulphureus.—Foveola of the vertex in the female slightly transverse, divided by a median carina, triangular in front, the margins raised and connecting in front, or approaching near to each other in a right-angle; in the male somewhat elongate; the frontal costa prominent, more or less bisulcate above the ocellus, very slightly sulcate below it; face seen from the side decidedly arcuate. Pronotum scarcely constricted in the middle, but expanding slightly and regularly posteriorly; median carina prominent, sub-cristate or cristate, more or less arcuate on top; lateral carinæ obsolete; surface somewhat roughened or rugulose; front margin obtuse-angled, slightly advanced upon the occiput; posterior margin right-angled or acute-angled. Elytra, and wings passing the abdomen. Antennæ slender and filiform.

Of an almost uniform dusky-brown color, varying from ash-brown to very dark brown; elytra rather paler than the pronotum and more or less distinctly spotted with dark brown. Wings a bright sulphur-yellow with a broad dusky or black outer margin, and a very distinct dark ray running inward toward and nearly to the base near the front or costal margin, leaving a narrow yellow stripe along the costal margin; the dark border occupies about one-third of the wing, narrowing as it curves round toward the anal angle, which it does not reach. Posterior femora usually marked with alternating bands of black and white, three of each; posterior tibiae dusky, black or blue-black, with a pale ring near the knee, spines black.

Var. xanthopterus.—This differs from the preceding, as follows: The foveola of the vertex is usually open in front, its margins continuous with the margins of the frontal costa; the median carina of the pronotum is higher and more distinctly arched, the angle of the anterior more distinct, and of the posterior margin more acute. The yellow of the wings is deeper and more inclined to a saffron color; the dark sub-marginal ray is short, not extending more than one-third the distance to the base. It is usually larger than *sulphureus*, the length of the female to the tip of the wings in some cases being fully two inches.

Var. carinatus.—Similar in every respect to *xanthopterus*, except that the wings are more of an orange or reddish-yellow, and the median carina of the pronotum slightly more elevated, and the arch not curving down quite so rapidly at the posterior extremity.

Length of body of this species varies from less than an inch to an inch and a half.

Common throughout the State; *xanthopterus* being apparently the southern type, and *carinatus* the western.

12. TOMONOTUS NIETANUS, Sauss.

Closely allied to *T. sulphureus*. Upper part of the head regularly convex; central foveola of the vertex sub-elongate, with a slender median carina, and a transverse sulcus across the hinder portion, generally truncate and closed in front; upper part of the frontal costa subtricarinate; rest flat, arcuate below as seen from the side. Antennæ slightly flattened and somewhat enlarged toward the tip. Median carina of the pronotum distinct, somewhat prominent but less so than in *sulphureus*, nearly straight on top, cut near the middle by the transverse sulcus, but not notched; anterior margin of the pronotum obtusely rounded, apical angle about a right angle, lateral carinæ subdistinct; disk of the posterior lobe nearly flat. Elytra and wings pass the abdomen.

Nearly uniform dark fuscous, often ash-color sprinkled over with fuscous dots, males sometimes almost black; face paler, dotted over with black points; mouth whitish or pale; outer joints of the palpi usually whitish or pale; pronotum above, is sometimes paler, of a dull, dirty-yellow, or partially of this color, usually dusky or brown. Elytra almost uniformly mottled with fuscous, the outer half interspersed with paler spots; but the shading varies in depth. Wings with the broad basal portion bright red; a broad black band around the outer margin, with a dark sub-costal ray extending toward the base; the extreme tip transparent more or less, clouded or spotted with fuscous. Posterior femora usually crossed externally by three pale bands; posterior tibiæ black at the knee, below which is a pale ring, middle portion varying from bluish green to black. The pale markings are very variable and sometimes entirely absent.

The size of the female varies from 1.5 to 1.8 inches to tip of elytra; of the male from 1.15 to 1.4.

This species has been observed occasionally in the extreme north-western part of the State. As will be seen I have adopted the name *T. nietanus*, of Saussure, instead of *T. tenebrosus*, of Scudder: further study of the species has sufficed to convince me, notwithstanding the statement in my Synopsis, that the two are identical or but varieties of one species. The only character given by Saussure, which leaves any doubt, is the carina in the lateral foveolæ of the vertex: I find occasionally a minute tubercle which appears to represent it, but have so far failed to find a true carina in these.

13. OEDIPODA AEQUALIS. Say.

Vertex of moderate width; foveola very shallow, especially in the female, slightly elongate, and in the male divided by a dim carina; lateral foveolæ almost obsolete; frontal costa sulcate, slightly in the female, more distinctly in the male, reaching nearly or quite to the clypeus. Median carina of the pronotum prominent on the anterior lobes, distinct, but less prominent on the posterior lobe, severed once near the middle, with a notch; front part compressed as usual, but less wrinkled than many other species; posterior lobe nearly flat on the disk, slightly rugulose, especially in the female; anterior margin slightly angled; posterior extremity about a right angle; lateral carinæ subdistinct, rounded. Elytra and wings passing the abdomen about one-fourth their length. Posterior femora in the female about as long as the abdomen. Antennæ passing the thorax.

Color.—Ash-gray mottled with dusky-brown and white. Face white, mottled with fuscous, or fuscous mottled with white; occiput dark-fuscous. Pronotum dusky-brown, with a dim, pale, broad stripe along the margins of the disk, bending inward at the middle with the lateral

carinæ, sprinkled over with darker dots. Elytra semi-transparent at the tip; with numerous dusky spots, which run together so as to form three transverse bands, the outer one indistinct; apical portion with a few spots. Wings yellow at base; a broad, black, well-defined band occupying the penultimate fourth, curving and decreasing along the posterior margin, reaching the anal angle; apical portion transparent, with dark nerves; apex with one or two dusky spots. Posterior femora with three white bands; posterior tibiæ red with a white ring near the base.

Dimensions.—*f.* Length, 1.12 to 1.25 inches; elytra, 1.10 inches; posterior femora, 0.62 inches; posterior tibiæ, 0.56 inches. *m.*—Length, 0.9 to 1 inch; elytra about equal the body.

So far as my observation and information extend, this species, although found throughout the State, is not very common. It is probable it will be more frequently met with in the northern than in the southern portion.

14. OEDIPODA COLLARIS. Scudd.

Central foveola of the vertex rather broader than long in the female; in the male very slightly elongate; frontal costa flat or convex above the ocellus, with a shallow sulcus below; sides nearly parallel. Median carina of the pronotum prominent, sub-cristate, with a very narrow but deep oblique notch a little in advance of the middle; the top slightly arcuate; lateral carinæ indistinct; sides of the disk ascending. Elytra and wings pass the abdomen about one-third their length.

Color.—Dark reddish-brown. Lower half of the head and a broad band along the posterior edge of the pronotum a clay-yellow, sprinkled with a few fuscous dots. Elytra mottled somewhat uniformly with fuscous blotches and dots, which form three irregular bands, one at the base, which is broad, the middle one narrowest, the apical one sometimes lost in the nearly equal mottling of the tip. Wings pale yellow at base; a broad median black band occupying the middle third, crossing the wing at right angles, decreasing along the posterior margin, around which it curves to the anal angle, throwing out a short, blunt, sub-frontal spur about one-third the distance to the base; apical portion transparent, nerves dusky, and tip clouded or with dusky spots. Hind femora clay-yellow, with two bands and apex fuscous externally and black internally; hind tibiæ reddish. Antennæ fuscous at the apex.

Dimensions.—*f*—Length, 1.25 inches; elytra equal to the body; hind femora, 0.7 inch; hind tibiae, 0.64 inch. *m*—Length, 0.9 to 1 inch.

This species is probably found throughout the State, but is not abundant.

15. OEDIPODA CAROLINA. Linn.

Vertex rather broad; foveola slightly elongate, open in front, with a slight depression at the tip; lateral foveolae minute, shallow; frontal costa sulcate from the ocellus down, slightly contracted immediately below the ocellus. Pronotum contracted and wrinkled in front; last transverse incision distinct, severing and notching the median carina; median carina slightly crested, posterior portion arcuate, anterior portion nearly straight on top; anterior margin somewhat angled at the middle; posterior margin acute angled. Elytra and wings passing the abdomen about one-third their length. Posterior femora shorter than the abdomen.

Color.—Dull ashy-brown, sprinkled with small dusky spots. Spots on the head and thorax minute, sometimes absent; on the elytra a little larger, sometimes aggregated in the middle portions, sometimes almost or quite obsolete. Wings deep black, except the outer margin which is pale greenish-yellow; the apex dusky, with a few spots. Posterior femora mostly black inside; a pale annulation near the apex.

Dimensions.—*f*—Length, 1.5 to 1.75 inches; elytra length of the body; posterior femora about half the length of the body. *m*—length, 1 to 1.25 inches.

This species appears to be found throughout the United States and although never very abundant is yet common during the summer. It is one of our most easily recognized species by its broad black wings which are very conspicuous.

16. OEDIPODA BELFRAGII. Stal.

As I have never met with this species I give here Stal's original description.

Fuscous-brown; the head variegated with cinereous; carina of the head and of the posterior femora, also the posterior margin of the

pronotum sprinkled with black; antennæ annulated with fuscous. Pronotum with the posterior margin acute angled; crest somewhat prominent, profoundly incised between the lobes. Elytra pale, grayish-brown, somewhat translucent toward the apex, where they are also clouded with fuscous. Wings pale yellow at base, with a broad black band across the disk arcuate and narrowed internally; apex transparent, with fuscous veins. Anterior legs subannulated with fuscous; posterior femora with the faciæ and apex black, the inferior margin and exterior side hairy; posterior tibiæ pale yellowish, fuscous at the base; spines tipped with black; hairy.

Female.—Length, 25 millimeters.

I am inclined to think that this is found only in the extreme northern parts of this State and in Michigan. Prof. Peabody informs me that he has found some specimens in the extreme northeast corner of the State which he is inclined to think belong to it.

17. TRIMEROTROPIS VERRUCULATA. Scudd.

Although placed by Mr. Scudder in a different genus it is closely allied to *Oedipoda aequalis*, from which it differs as follows:

Frontal costa of the female rather more distinctly sulcate. Middle carina of the pronotum less distinct on the posterior lobe, and a little less elevated on the anterior lobes, notched and severed in two places, the middle portion the shortest. Elytra and wings appear to be a little longer compared with the length of the body, and the wings more distinctly papilioniform.

Color.—Ash-brown, varied with dusky-brown. Face ash-brown with dusky dots, male darkest. Pronotum a little darker, dusky spots larger than on the face; lateral stripes scarcely distinguishable. The black band of the wings is narrower, the outer and inner borders more irregular, somewhat broken at the first sub-frontal nerve, does not reach the anal angle; the sub-frontal space dusky nearly to the base; apex dusky, with a few small fuscous dots. Base and apex of the posterior tibiae black; middle portion yellowish or plumbeous, generally, with a dusky annulation near the middle.

Dimensions.—*f*—Length, 1.10 inches; elytra, long as the body; posterior femora, 0.57 inch; posterior tibiæ, 0.5 inch. *m*—Length, 0.9 to 1 inch.

18. TRIMEROTROPIS MARATIMA. Harr.

Central foveola of the vertex slightly elongate; middle line seldom present in the female, absent in the male; open in front, and the margins continuous with the margins of the frontal costa. Frontal costa sulcate, slightly in the female, distinctly in the male. Median carina of the pronotum simply a raised line on the posterior lobe, slightly more elevated on the middle and anterior lobes, twice severed by transverse incisions; lateral carinæ sub-distinct; disk of the posterior lobe flat; apex right-angled. Elytra and wings passing the abdomen; posterior femora about equal to it. Antennæ rather longer than usual.

Color.—An ash-gray; tinged with brownish. Face variegated with white, or pruinose. Pronotum sometimes striped on the sides with brown, especially in the male, sometimes brown throughout. Elytra sprinkled with minute, brownish spots, chiefly along the middle and lower half; dorsal margin somewhat pale, unspotted; the dorsal angle tinged with reddish; semi-transparent at the apex. Wings a transparent yellow at base; a narrow, curved, fuscous band across the middle, interrupted near the front margin, where it bends in toward the base a short distance, but does not reach the anal angle; apical portion transparent. Posterior femora with two brown bands on the upper half, inside and outside; with pale yellow ring near the apex; tibiæ yellowish.

Dimensions.—*f*—Length 1.25 inches; elytra 1.15 inches; posterior femora 0.63 inch.; posterior tibiæ 0.56 inch. *m*—Length, 0.75 to 0.9 inch.

This, so far as I am aware has been discovered only in the extreme northern part of the State. It will not be found in my list of Illinois Orthoptera published in Bulletin No. 1, of the Illinois Museum of Natural History, for the reason that I was not then aware it had been found in the State.

19. MESTOBREGMA CINCTA. Thos.

Female.—The head, seen from the side, shows the crown somewhat elevated, the eyes also standing high. Vertex deflexed, broad, sub-hexagonal; the front portion prolonged; the margins continuous with the sides of the frontal costa. Frontal costa narrow above, gradually expanding below, and sulcate throughout. Pronotum short, the length not exceeding the depth, strongly contracted a little in advance of the middle; the disk somewhat rugose, that of the posterior lobe nearly flat; the median carina slightly elevated on the front lobes,

twice distinctly notched; the middle portion shortest and rounded; the whole of the disk, especially the posterior lobe, more or less covered with small tubercles; lateral carinae obsolete on the anterior lobes, and obtuse and indistinct on the posterior lobe; the posterior angle a little larger than a right-angle. Elytra and wings extend beyond the apex of the abdomen. Posterior femora rather short, not reaching the tip of the abdomen in the female; broad at base, with a sharp, elevated upper carina, which suddenly decreases about one-third the length from the apex; the lower edge generally hairy. Antennae longer than the head and pronotum, filiform.

Color.—Fuscous and pale yellowish-brown, or ash, about equally distributed in stripes and spots, the ash or yellowish brown portions more or less mottled with fuscous dots and points. The dark on the head as follows: two stripes running back from the eyes, one from the upper, the other from the lower corner; the lower portion of the cheeks and the lower margin of the face; and some dots on the margins of the frontal costa. On the pronotum a broad pale stripe runs along each lateral carina, converging in front of the middle; the margins of the posterior portion are pale, joined interiorly by a black stripe; the central space pale; the sides marked with alternate stripes of pale and fuscous. Elytra fuscous at the base, becoming transparent a little beyond the middle, where the netted nervules suddenly cease; a narrow whitish line along the angle; the lower field has two sub-quadrangle black spots separated by an elongate whitish spot. Wings transparent; base greenish-yellow; a narrow fuscous band across the middle; apex pellucid, with a few fuscous dots at the tip. Posterior femora ash-colored, with three black spots on the upper margin of the outer face; base and a band on the inside black. Posterior tibiae with a broad white ring near the base, rest blue; tarsi yellow. Venter and pectus white.

Dimensions.—Length, 1 inch; elytra, 0.92 inch; posterior femora, 0.56 inch; posterior tibiae, 0.48 inch.

I have taken a few specimens of this species in Southern Illinois, but it is by no means common.

20. HIPPISCUS NEGLECTUS. Thos.

Somewhat like the male of *Oe. corallipes*, Hald. Vertex broad, transverse; the large central foveola is divided by a single or double carina, which runs from the center of the front margin back two-thirds across it; when double, the infolding of the margin, seen from the front, resembles a w; lateral foveolæ shallow, but distinct, frontal costa bi-sulcate above the ocellus, slightly sulcate below. Median carina of the pronotum simply a raised line, distinctly severed by the

third cross incision; lateral carinae sub-distinct; anterior portion rugose on the dorsum, and wrinkled on the sides; disk of the posterior lobe flat, covered with elongate tubercles, sides granulose; anterior margin sub-truncate; apex about a right angle. Elytra and wings extend beyond the abdomen. Antennae slightly passing the thorax.

Color.—(dried after immersion in alcohol)—Pale reddish-brown. Elytra brownish at the base, paler and semi-pellucid toward the apex, with dim, brown, cellular spots scattered somewhat equally over it, fading toward the apex; in some specimens are almost or quite obsolete; in others they are distinct, somewhat fuscous, and partially run together. Wings pale-red at base (orange red when living); crossed by a narrow, somewhat broken, cellular, dark band beyond the middle, which curves round the posterior border, decreasing rapidly and not quite reaching the anal angle; a broad ray of the same running up the front margin to the base. Posterior femora dull yellow, with no distinct bands.

Dimensions.—1.4 to 1.6 inch; elytra 1.25 to 1.30 inch; hind femora 0.70 to 0.75 inch; hind tibiae 0.62 inch.

21. HIPPISCUS CORALLIPES *var.* RUGOSUS. Scudd.

(*Oedipoda rugosa*, Scudd.)

Head and thorax of unusual depth in the female; head rather broader than the middle of the pronotum. Vertex broad, transverse, with two rather distinct sub-pentagonal foveolæ, the sharper angle directed obliquely backward toward the eye; lateral foveolæ small; frontal costa flat or convex above the ocellus, scarcely sulcate in the lower part; face seen from the side arcuate. Antennae of the female small, not reaching the apex of the pronotum; those of the male flattened and longer. Pronotum rugose with small tubercles and raised lines; less so in the male; median carina distinct, but not elevated, cut rather behind the middle; posterior lobe with the disk flat; lateral carinae sub-distinct on the anterior and posterior lobes. Wings and elytra a little longer than the abdomen. Posterior femora very broad, about as long as the abdomen in the female.

Color.—Yellowish-brown, varied with fuscous. Head and thorax brown, mottled with darker brown; males sometimes reddish-brown, not mottled. Two yellowish bands run from behind the eyes backward and inward, nearly or quite meeting one another a little in advance of the middle of the pronotum, where they diverge and strike the hind margin of the pronotum at the outer angles; two or three dull yellowish spots on the sides. Elytra pale ash-brown, with large fuscous spots, and a narrow pale stripe along the dorsal angle. Disk of the wings yellow, varying in different specimens from pale-transparent to orange-yellow; a moderately broad, dusky band across the

middle, curving round the hind margin nearly to the anal-angle, and extending up the sub-frontal space to the base; apex transparent; veins dusky. Posterior femora crossed externally and internally by three black bands; posterior tibiæ reddish-yellow, with a broad, pale ring near the base.

Dimensions.—*f.* Length, 1.4 to 1.7 inches; elytra, 1.28 inches; posterior femora, 0.90 inch; posterior tibiæ, 0.82 inch. *m.*—Length, 1 to 1.25 inches.

22. HIPPISCUS DISCOIDEUS. Serv.

Female.—Of large size. Vertex broad, the slightly elevated margins suddenly curved outward opposite the eyes; a slight median line, with minute tubercles at the tip. Face slightly curved under; frontal costa prominent, broad, somewhat expanding below, and obtusely sulcate; lateral carinæ distinct, curving outward to the corners of the face. Pronotum covered somewhat regularly with small tubercles, otherwise not very rugose, being but slightly wrinkled transversely; median carina moderately elevated, nearly straight on top, interrupted only by one slight notch; lateral carinæ wanting on the anterior lobes, distinct, but obtuse on the posterior lobe. Elytra and wings longer than the abdomen; there is in the female a distinct expansion of the lower border of the elytra near the base, the nerves of the dorsal field ramose and prominent. Posterior femora very broad, the width near the base being about equal to the width of the elytra; the upper and lower carinæ much elevated and sharp; not reaching the tip of the abdomen. Valves of the ovipositor very robust, elongate.

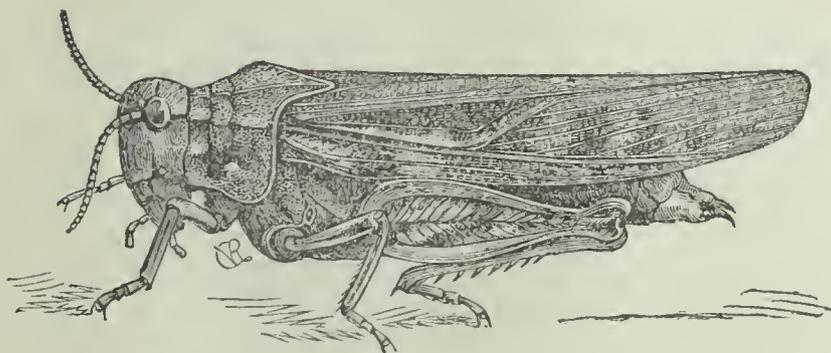
Color.—Pale-reddish or yellowish-brown, with dark-brown or fuscous spots. Head and thorax (in dried specimens) dark reddish-brown, the sides of the pronotum nearly black; it is probable that this in living specimens, is paler and tinged with olive-green. Elytra roseate and somewhat opaque at the base, transparent at the apex, marked with tolerably large dark-brown spots, somewhat elongate transversely, placed irregularly; one of the largest crosses the lower field at the expansion near the base. Wings with the disk and basal portion a bright, deep orange-red, semi-opaque; exterior to this and just beyond the middle they are crossed by a rather a narrow fuscous band, which curves round on the posterior margin to the anal angle; it also curves slightly inward in front; exteriorly it fades into the black-nerved, transparent, apical portion; the anterior margin is bordered with a red stripe, which extends to the base; this is separated from the red of the disk by a black ray, which also extends nearly to the base. Abdomen glabrous, much more so than the rest of the body. Legs glabrous, of a clear reddish-brown; the posterior femora internally deep

blue, with a yellow ring near the apex; external face with three indistinct oblique bands. Posterior tibiae yellowish, slightly tinged with red. Antennae fuscous.

Dimensions.—*f*—Length, 1.75 inches; elytra 1.50 inches; posterior femora, length 0.93 inch, width 0.3 inch; posterior tibiae, 0.76 inch.

23. HIPPISCUS PHOENICOPTERUS. Burm.

FIG. 18.



Hippiscus phoenicopterus.

Vertex rather broad; central foveola slightly elongate, divided into two parts by a median carina; lateral foveolæ nearly obsolete; frontal costa closed above the ocellus, sulcate from the ocellus down, not reaching the clypeus. Median carina of the pronotum distinct and slightly elevated; but not cristate,

upper margin slightly depressed and severed a little before the middle; lateral carinae distinct; disk flat; anterior margin sub-truncate; apical little less than a right-angle; disk granuloſe. Elytra and wings passing the abdomen. Antennae of the male somewhat flattened, joints sub-distinct. Posterior femora remarkably broad.

Color.—Testaceous-brown. Face ashy-brown, cheeks paler; occiput dark-brown. Pronotum sometimes almost uniformly brown; at others, the disk has on each side a broad testaceous stripe, also a spot of the same near the front margin, and another near the center of the sides. Elytra with the costal margins pale and unspotted; middle field fuscous, with a testaceous stripe, also a spot of the same near the front margin, and another near the center of the sides. Elytra with the costal margins pale and unspotted; middle field fuscous, with a testaceous stripe along the middle nerve near the base, which bends upward near the center; beyond this is a triangular spot of the same, with the base on the middle nerve; varied with fuscous spots and testaceous near the apex. Wings with the disk vermillion-red, a tolerably broad, fuscous, arcuate band beyond this, marginal behind, reaching the anal angle; a broad marginal ray of the same extends along the front to the base, separated from the red by a narrow transparent ray; apex dusky. Posterior femora testaceous, crossed externally by three narrow curved bands, spotted inside with black; tibiae dusky.

Dimensions.—*f*—Length, 1.45 inches; elytra, 1.24 inches; posterior femora, 0.87 inch long, 0.25 inch wide; posterior tibiae, 0.73 inch. *m*—Length, 1.05 inches.

24. CAMNULA PELLUCIDA. Scudd

Size small. Foveola of the vertex distinct, sub-elongate, triangular; apex closed and rounded; frontal costa narrow and convex above, expanding below, impressed at the ocellus, not sulcate. Pronotum much like that of the *Stenobothri*; tricarinate; median carina distinct and slightly prominent, continuous and solid, straight on top; lateral carinae distinct, but not raised, slightly arcuate along the posterior lobe, most convergent near the front margin; disk nearly flat; no transverse impressions distinct on the disk; anterior margin slightly angled; posterior extremity also obtuse angled. Elytra and wings pass the abdomen slightly. Posterior femora about as long as the abdomen in the female.

Color.—Ash-brown. Face reddish-brown; antennae yellowish at base, dark-brown towards the apex; a triangular black spot behind the eye, apex touching the eye. A quadrate, transverse, black spot on the anterior part of the sides of the pronotum; disk sometimes has a dark band along the middle. Elytra fuscous-brown; a yellow stripe along the dorsal angle; a yellow line reaches from the base along the sub-frontal nerve to a yellow spot on the lower (or front) margin, near the middle; apical half and lower margin marked with yellow lines and fuscous spots. Wings pellucid with black nervules. Legs dark-brown; the hind femora yellowish or reddish-brown, with two or three rather broad, oblique, dark-brown streaks, dark at the apex; hind tibiae yellowish-brown, reddish towards the tip, with a very narrow, generally faint, annulation of dark-brown at the base; spines tipped with black.

Dimensions.—*f*—Length, 0.9 to 1 inch; elytra, 0.75 inch; hind femora, 0.55 inch; hind tibiae. *m*—Length, 0.65 to 0.70 inch.

25. PEZOTETTIX UNICOLOR. Thos.

Female.—Occiput short; vertex rather broad, elongate, channeled, the slightly elevated margins continuous with the margins of the frontal costa; frontal costa prominent, slightly sulcate, and somewhat expanding at the ocellus; lateral carinae distinct but not very prominent; eyes sub-elongate, acuminate at the apex. Pronotum regularly angled; sides parallel; tricarinate; carinae equally distinct; sides flat, compressed; the two sides of the disk flat but slightly ascending to the median carina; posterior sulcus situated behind the middle, distinct; the first and second indistinct; all somewhat distantly separated.

Elytra about half as long as the abdomen, oblong-ovate; wings minute. Abdomen compressed, pisciform. Posterior femora passing the abdomen slightly. Prosternal spine of moderate length, very broadly transverse, the width nearly equaling the length, blunt and rounded at the apex.

Color.—Reddish-brown throughout, varying slightly in depth of color. Elytra unspotted. The hind femora have the spaces between the ribs of the disk marked with minute, elongate, red spots, which are surrounded by testaceous rings; (these can be distinctly seen only with a magnifier). The posterior lobe of the pronotum and a ring round the front sub-margin rather coarsely punctured; the sides glabrous.

Dimensions.—Length, 0.88 inch; elytra, 0.26 inch; posterior femora, 0.55 inch; posterior tibiæ, 0.46 inch.

26. PEZOTETTIX MINUTIPENNIS, Thos.

Female.—Head short, eyes approximate above; the vertex very narrow between them, suddenly expanding to lateral angles just in front of them, slightly, sometimes scarcely, sulcate. Face, seen from the side, oblique and arcuate; frontal costa somewhat prominent, continuous nearly or quite to the clypeus, sides parallel, not, or very slightly, sulcate. Pronotum, cylindrical, the median carina distinct, though it is but a very slender line; lateral carinæ wholly obliterated; sides nearly parallel, expanding very slightly posteriorly; anterior margin squarely truncate; posterior truncate, with a slight notch at the middle, sometimes scarcely distinct; the posterior transverse incision is situated much behind the middle, reducing the posterior lobe to but one-third the length of the pronotum; the posterior later angle rounded, and the margin from thence up to the middle rounded with no inward curve or notch except the one at the middle of the dorsum.

Elytra minute, not meeting on the back, the space between them being more than the width of one of them; narrow, spatulate, width about one-third the length; extending over the second abdominal segment; longitudinal nerves prominent and similar. Abdomen somewhat prominent and carinated at the base, but suddenly decreasing in size posteriorly, so that near or a little beyond the middle it becomes cylindrical. Anterior femora slender; posterior femora about as long as the abdomen; upper carina distinct, and the upper external angle distinct and somewhat sharply defined; the tibiæ distinctly expanding below. Prosternal spine broad at base, transverse, bluntly rounded at the tip.

Color.—Head and thorax varying in different individuals from dull greenish white to brown, with a clearly defined shining black line extending on each side, from the eye to the posterior margin of the pronotum. Posterior femora bright pea-green, unspotted except the tip, which is black; tibiæ greenish, with the spines black.

Male.—Much smaller than the female; eyes very prominent, and so closely approximate above that the portion of the vertex between them is reduced to a mere thread; the antennæ comparatively large and reaching back to about the tip of the tip of the second abdominal segment. Tip of the abdomen strongly curved upward; cerci somewhat elongate, slender, and narrowed in the middle; tip of the last ventral segment somewhat conical, entire. Face quite oblique and arcuate.

Color—(of the single specimen seen).—Face and disk of the pronotum dull ash-brown; cheeks and space of the pronotum below the black stripe pale ash-brown, or rufous; posterior femora greenish-yellow, deeply tinged with bright-rufous above.

Dimensions.—Female, length .90 inch; male, length .65 inch.

27. PEZOTETTIX VIOLA. Thos.

Female.—Rather large and robust, resembling somewhat a short-winged *Caloptenus bivittatus*, excepting the stripes.

Vertex and frontal costa not, or but slightly sulcate. Pronotum with the median carina slight; lateral carinae, or rather lateral angles (not being true carinae) somewhat distinct; disk flat; sides flattened and perpendicular; posterior margin obtusely rounded; posterior lateral margins with a distinct inward curve or rounded notch at the humerus, the portion below the notch perpendicular. Elytra ovate-lanceolate, the externo-median nerve distinct; not always meeting at the base, but overlapping more or less toward the apex; varying in length from about one-third to more than one-half that of the abdomen, occasionally almost as long as the abdomen.

Color.—Varying from a dull olive-brown to ash-brown. Head and thorax brown; elytra with the upper field, or dorsal portion pale yellowish brown; lower fields, or lateral portion brown, varying from light to very dark brown; sometimes almost black; the paler specimens usually have a few dark brown, rather small spots along the disk or near the tip; the posterior femora reddish with oblique brownish bands; posterior tibiae rufous.

Dimensions—Length, 1 to 1.2 inches.

28. PEZOTETTIX SCUDDERI. Uhler.

Resembles somewhat strongly a short-winged *Caloptenus femur-rubrum*. General color reddish-brown and fuscous. The cranium is less prominent than in *C. femur-rubrum*; the thorax slightly broader, and in the female the black stripe on the sides of the head and pronotum is much narrower, and sometimes entirely obsolete; the whitish oblique stripe on the metathorax indistinct and sometimes entirely obsolete. The elytra do not reach beyond the apex of the second abdominal segment. The underside of the posterior femora is yellow, and the tibiæ have a black dot on the knee, and a black ring just below it. The tip of the last ventral segment of the male is more narrowed, acute and conically produced than in *C. femur-rubrum*. In other respects than those mentioned it agrees with this species.

Length of female .8 to .9 inch; male .6 to .7 inch.

I am not certain that I have met with any specimens of this species obtained in Illinois; it is inserted in our list on the statement of Mr. Walsh that he had observed it at Rock Island.*

I have considerable doubt in reference to the species, and do not understand why Mr. Uhler, who is usually so full and exact in describing species, should have given so imperfect a description in this case, which I have given above almost in his own words.

NOTE.—Have since seen specimens collected in Illinois.

29. THE ROCKY MOUNTAIN LOCUST—(*Caloptenus spretus*—Thos.)

FIG 19.

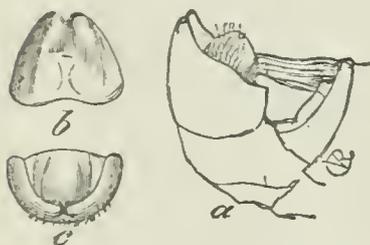


Caloptenus spretus, Female.

Female.—The face nearly perpendicular, sloping under toward the breast very slightly. The vertex between the eyes the same width as the frontal costa just above the ocellus; that portion in front of the eyes more or less distinctly channeled, and deflexed at an angle of about 40 degrees from horizontal. Eyes nearly straight in front, about semi-circular behind. Antennae quite slender, reaching little if any

beyond the tip of the pronotum. Pronotum, with the sides of the anterior lobes parallel, the posterior lobe expanding rapidly backward; median carina thread-like, but always distinct on the posterior lobe, usually obsolete on the anterior lobes; lateral carinae obtuse but distinct on the posterior lobe and usually so on the middle one but becoming obsolete toward the front; posterior lateral margin, perpendicular from the humeral (entering) angle one-third the way down, then curving forward to the posterior lateral angle which is obtuse and rounded; the (entering) humeral angle is sharply defined, and in this respect differs from *C. femur-rubrum* and *C. atlantis*; the apex is obtuse-angled (about 100°) rounded at the point; posterior lobe minutely and shallowly punctured throughout; the anterior lobes smooth with few or no punctures except along the lower margins of the sides. Elytra and wings extending beyond the tip of the abdomen from one-fourth to one-third their length; the elytra are of nearly uniform width throughout, slightly curving upward at their extremity; wings a little shorter than the elytra, very thin and delicate; nerves and nervules very slender. Abdomen, and in fact the whole insect rather more slender than usual in this genus; but this appearance is partly due to the elongated wings; cerci very small, triangular or tooth-shaped, not extending across the segment on which they rest; valves of the ovipositor quite prominent, especially the upper pair which are more than usually exerted, sharp at the tips and deeply excavated above. The posterior femora usually extend to or about to the tip of the abdomen.

FIG. 20.



Tip of the male abdomen of *sprutus*; *a* lateral view of the terminal segments; *b* under side of terminal segment; *c* upper side of same.

Color.—Reddish-brown with fuscous spots. Head and the pronotum back to the posterior sulcus reddish-brown, varying in depth of color in individuals; the face is sometimes of a lighter and brighter red than the pronotum, sometimes darker, assuming a dark purplish hue; the posterior lobe of the pronotum is generally a pale olive-brown, its lighter color contrasting somewhat distinctly with the darker shades of the anterior portion. Some individuals exhibit much lighter colors than here described, varying from a dark-brown to a dull yellow. The dark line on the side of the

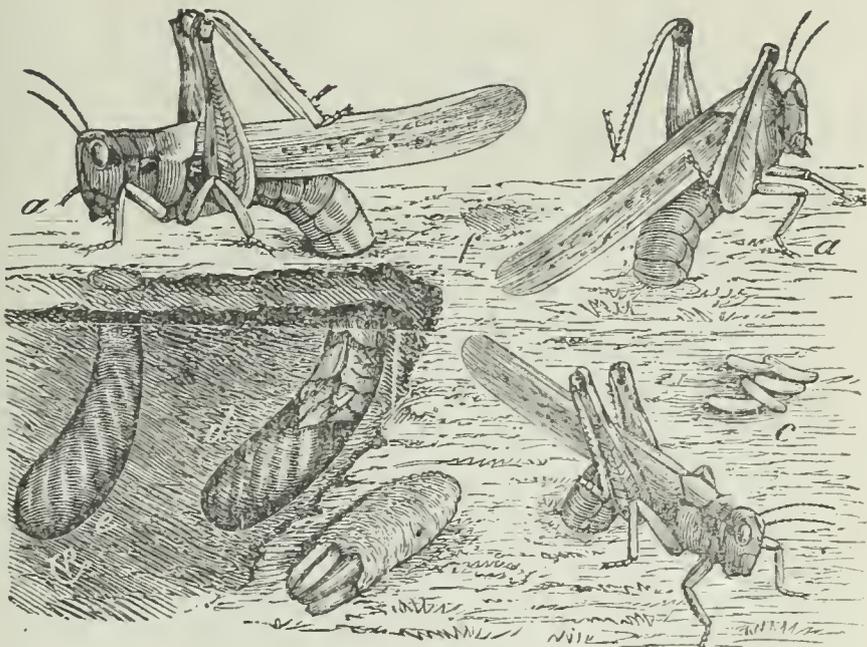
head and pronotum, usually so conspicuous in the closely allied species, is generally obliterated in this species by the dark-brown color; but it usually appears distinctly in specimens which have been immersed for sometime in alcohol, and is also manifest in the pale individuals, but is broken up by pale spaces and lines, and is rather narrow; the eyes shining black; elytra ash-brown, more or less tinged with reddish-brown at the base and fading toward the apex; in the middle field, commencing near the base, where this field comes to a point, is an irregular row of fuscous dots, usually single to where the thin portion commences, now and then a double dot appearing; from this point to the apex they decrease in size and distinctness, and spread over the entire width; as a general rule the inner field is marked with a few fuscous dots, in some individuals a few quite distinct are seen, in others they are very minute and dim, and not unfrequently they are entirely wanting. Wings transparent, with a very slight yellowish tinge at the base; nerves and nervules of the costal

area and apex black, rest pale. The abdomen is generally a glossy brown, with the posterior margins of the segments pale; venter yellowish or pale brown; sternum pale brown or yellow; anterior and middle legs usually rufous, but varying from reddish-brown to pale honey-yellow. Posterior femora with the disk reddish-brown, sometimes showing dim outlines of oblique bands; the inner face and lower carina yellowish, the latter usually tinged with red; the upper carina and upper portion of the inner face yellowish, marked with three large black spots or partial bands, one at the base, the other two equally spaced in the middle area; apex or knee black, or with a black crescent each side. The posterior tibiae vary in color from a bright coral-red to a pale yellow, and in some cases to bluish.

Male.—Differs from the female as follows: Is somewhat smaller and shorter; but the wings are about as long as those of the female; the abdomen is enlarged or widened posteriorly and strongly curved upward at the apex; the last ventral segment being elongated, rounded and narrowed upward like the prow of a boat, and is distinctly notched at the tip, the lips or lobes somewhat tubercular in form. This part of the apical segment is covered with minute scattering hairs. This notch forms one of the chief characteristics of the species, at least the most important one in distinguishing it from *femur-rubrum*. The super-anal plate or triangular piece above the anal opening, is sharply bicarinate longitudinally; the tooth-like appendages at the base, above, are narrow and slender. The cerci are somewhat longer than the width of the preceding segment, are broad and flat throughout, the width equaling two-thirds the length, not suddenly narrowed or constricted, moderately curved upwards and inwards; roundly narrowed and depressed at the apex. The prosternal spine (in both sexes) is subquadrate and large at the base, but distinctly transverse; robust and decidedly conical, gradually lessening to a blunt point.

Dimensions.—Female. Length to tip of elytra, 1.15 to 1.43 inch, usually about 1.30; length of elytra beyond the tip of the abdomen, 0.15 to 0.48 inch; usually 0.22 to 0.27 inch. Male. Length to tip of elytra, 1.15 to 1.40 inch; usually 1.20 to 1.30 inch; length of elytra beyond the tip of the abdomen, 0.20 to 0.38 inch, usually 0.25 to 0.33 inch.

FIG 21.



Calaptenus spretus. *a a a* females in the act of depositing their eggs; *b* an egg pod with one end open showing the eggs; *c* eggs separated from the pod; *d* and *e* show the egg-pods in their usual position in the earth; *f* shows where a pod has been deposited and the hole closed.

30. THE LESSER LOCUST—(*Caloptenus atlantis*). Riley.

The species most closely allied to *spretus*, or the Rocky Mountain locust, is *C. atlantis*, Riley, or the "Lesser Locust," which the author describes as follows: "Length to tip of abdomen, 0.70 to 0.85 inch; to tip of the closed wings, 0.92 to 1.05 inches. At once distinguished from *femur-rubrum* by the notched character of the anal abdominal joint of the male, and by the shorter, less tapering cerci; also, by the greater relative length of the wings, which extend on an average nearly one-third their length beyond the tip of the abdomen in dried specimens; also, by the larger and more distinct spots on the wings—in all which characters it much more closely resembles *spretus* than *femur-rubrum*. From *spretus*, again, it is at once distinguished by the smaller size, the more distinct separation of the dark mark running from the eyes on the prothorax, and of the pale line from the base of the wings to the hind thighs; and also by the anal joint in the male tapering more suddenly, and by the two lobes forming the notch being less marked. From both species it is distinguished not only by its smaller size, but by the deeper, more livid color of the dark parts, and the paler yellow of the light parts, the colors thus more strongly contrasting.

"Just as the typical *femur-rubrum* is at once distinguished from the typical *spretus* by the characters indicated, so *atlantis*, though structurally nearer to the *spretus*, is distinguished from it by a glance at its much smaller size, and darker, more marked coloring. The contrast is all the greater in the living specimens of *spretus* that at all approach it in these respects."

I find the male, as seen in Illinois, varies in length to the tip of the elytra as follows: 0.97, .095, 0.98, 0.95, 0.96, 0.34, 1.05, 0.93—averaging 0.954.

31. THE RED-LEGGED LOCUST—(*Caloptenus femur-rubrum*)—Deg.

FIG. 22.



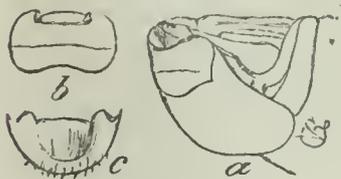
Caloptenus femur-rubrum.

This is our common Red-legged Locust, and has been so often mentioned and described in scientific and agricultural publications that I will simply refer to the differences between it and two other species (*spretus* and *atlantis*).

Female.—As compared with *spretus* the only very marked difference between the females is the shorter wings of this

species, yet there are other slight differences observable when a large number of specimens are compared. The eyes in *femur rubrum* are slightly more prominent; the head, pronotum and sides of the thorax are usually some shade of olive-brown, varying from pale to almost black; the black line behind the eyes is quite broad, seldom broken up, and is distinct in the darkest specimens. The humeral (entering) angles of the posterior margin of the pronotum are more rounded and not so sharply defined as in *spretus*; the median carina is usually more distinct on the anterior lobes, while the lateral carinae are rather more obtuse and not so well defined; the punctures on the posterior lobe are more distinct. The wings extend but slightly beyond the extremity of the abdomen, usually less than one-tenth their length. In this species and *atlantis* the intercalate vein is present in the elytra dimly and imperfectly, it is true, but it can be clearly distinguished for more than half the length of its course. In *spretus* it is wanting, its place being marked by the line of union between the two rows of cells. The fuscous spots or dots are not so conspicuous or widely spread over the apical portion of the elytra, and the elytra are narrower and straighter. As a very general rule the external face of the posterior femora is black or brown, the lower margin and lower half of the inner face bright coral red; when these colors are well defined there is a yellow space or stripe between the red and black; but these markings are subject to considerable variation, the red being sometimes entirely wanting, the external face dark and the lower margin yellow, sometimes the dark is replaced by a pale-olive. The tibiae are most generally bright red, but this character is not without its exceptions. Usually there is a pale ray extending from the base of the wings to the posterior coxa, but is occasionally wanting in dark specimens, and is generally absent in *spretus*. The prosternal spine is not so distinctly quadrate at the base as in *spretus*, transverse, flattened behind and not regularly conical, but somewhat sub-cylindrical to the broadly rounded and very blunt apex.

FIG. 23.



Tip of male abdomen of *femur-rubrum*. Letters have same reference as in Fig. 20.

Male.—The most constant difference between the species is found in the form of the last ventral segment of the male; in *femur-rubrum* this segment, although strongly curved upwards, as in *spretus*, is not so distinctly narrowed toward the end, but rounded, and instead of being notched toward the end, is squarely truncate, presenting a sharp, horizontal and almost semi-circular margin (see Fig. 23). Below the tip, on the posterior

face of the segment, is a rather large, transverse, gash-like indentation. The cerci are about the same length as those of the male *spretus*, and about the same width at the base. The little tooth-like appendages at the base of the super-anal plate are elongate and slender, as in *spretus*, and are sinuate.

In addition to the characters mentioned in the original description of *atlantis*, I would call attention to the following differences between it and *spretus* on the one side and *femur-rubrum* on the other.

Female.—As compared with the female of *spretus* the wings are shorter, extending but very slightly beyond the tip of the abdomen, not differing perceptibly in this respect from *femur-rubrum*; the elytra are narrower, curved upward very slightly at the apex, very few spots

or dots on the apical portion and these minute and dim; the inner field is almost always immaculate; the posterior half of the intercalate vein apparent. The wings pellucid, but when living have, next the base, a bluish-white tinge; a larger portion of the nerves and nervules dark. The black stripe on the side of the pronotum nearly always apparent even in the darkest individuals; head and anterior lobes of the pronotum with the velvety appearance so marked in *spretus*, but here dark or olive-brown without the reddish tinge so common in that species; the pale, oblique, metathoracic ray usually apparent but often obliterated.

There are no reliable characters by which to distinguish it from the female of *femur-rubrum*; the posterior lobe of the pronotum is usually less conspicuously punctured, agreeing in this respect with *spretus*.

Male.—Differs from *spretus* in being smaller, pronotum rather more constricted and sub-cylindrical; eyes more round and prominent; the notch at the tip of the last segment less distinct, sometimes almost obliterated; more of the nerves of the wings dark.

From the male of *femur-rubrum* it differs in usually having longer wings, in some individuals they are as long, proportionally, as in any specimen of *spretus*, in others little or no longer than in *femur-rubrum*; in the more slender form and smaller size; in having the apical segment of the abdomen narrowed and notched at the tip; in having the cerci broad throughout and shaped as in *spretus*; in having the tooth-like appendages at the base of the super-anal plate shortened and broadened, and with a longer union at their base.

It is evident from these characters that *atlantis* is an osculant form, intermediate between *spretus* and *femur-rubrum*, partaking largely of the characters of each, and in a few respects differing from both. The female approaches very near *femur-rubrum*, scarcely showing varietal differences from the female of that species; while on the other hand the male approaches much nearer *spretus*, as shown by the character of the terminal segment of the abdomen, the form of the cerci and the length of the wings.

32. CALOPTENUS BIVITTATUS, Say.

In this very common species, the vertex of the female is convex or but slightly depressed, and the frontal costa not sulcate; in the male the frontal costa is more or less distinctly sulcate. Elytra and wings but little longer than the abdomen. The last ventral segment of the male has the apical margin entire and circular. Pronotum with the sides straight, very slightly expanding posteriorly; posterior cross-incision distinct; posterior femora equal to or passing the abdomen.

Dull-green or olive-brown color, with a distinct yellowish or pale stripe along each side extending from the upper angle of the eye, along the lateral angle of the body to the extremity of the elytra. Mouth pale, face varies from yellowish to olive-brown; the disk of the pronotum from pale reddish-brown to dark olive-brown; as also do the elytra; the latter sometimes have a few quite small dusky spots on the disk, but generally they are unspotted. Wings transparent, tinged with greenish or greenish-yellow; nerves greenish-brown or blackish. Hind femora generally with a dark stripe along the upper edge of the disk; yellow below; upper margin with two pale spots; posterior tibiae usually red, but there is great variation in this respect, almost every color from black to yellow being found.

Length very variable; female 1. to 1.62 inches; male smaller.

One of our most common species, found everywhere throughout the State. I am inclined to believe the following species, *C. differentialis*, is somewhat superseding it.

33. CALOPTENUS DIFFERENTIALIS. Thos.

FIG. 24.



Caloptenus differentialis.

This is our largest species of this genus, quite robust; elytra passing the abdomen slightly and without spots or stripes; varying from a dull olive-green to an olive-brown; paler beneath.

Vertex oblongate, depressed, broadly sulcate, closed in front; frontal costa, broad, flat or slightly sulcate; sides parallel; lateral carinae distinct, slightly divergent. Pronotum sub-quadrangle; sides perpendicular, parallel; lateral carinae or humeral angles obtusely rounded; median carina small, but distinct, except on the post-median lobe of the female; third transverse incision very distinct and deeply indented, others distinct. Posterior femora much enlarged near the base, the disk convex, about as long as the abdomen; posterior tibiae enlarged near the tip, hairy. Prosternal spine cylindrical, bent slightly backwards. Sub-anal plate of the male triangular; apex blunt, entire; cerci with the basal half broad, an obtuse tooth about the middle of the posterior margin, above this, bent and tapering.

Color.—Male. Head and anterior lobes of the pronotum reddish or olive-brown; sides paler, with from one to three oblique, black lines; transverse incisions dark on the sides. Elytra unspotted, olive-brown, sometimes reddish at the base, semi-transparent. Wings pellucid; nerves of the apical and front portions dark, rest yellowish. Posterior

femora yellow; three black spots on the upper edge; interspaces of the disk black, ribs pale yellow; tibiæ usually yellow, spines black. Abdomen yellow, with small, black spots and stripes. Venter and pectus yellow or ash-yellow.

Female similar, except that the head and thorax are usually olive, and the legs and venter of a brighter yellow.

Length. Female, 1.4 to 1.8 inches; Male, 1.2 to 1.4 inches.

Found abundantly throughout the State.

34. ACRIDIUM RUBIGINOSUM. Harr.

Facial carinæ prominent, diverging but slightly; frontal costa sulcate its entire length, thickly punctured. Pronotum with a prominent median carina, continuous and slightly arched; scarcely expanding posteriorly; transverse impressions dim. Elytra and wings about as long as the abdomen; posterior femora of the female a little shorter.

Color, a light rust-red, somewhat uniform throughout. Elytra opaque, rather paler on the overlapping portion, without spots, or sprinkled over with dim, small, dusky spots. Wings transparent, slightly reddish toward the tip; veins blackish. Posterior femora reddish; the flat disk whitish, with a row of black dots above and below; apex with a lunate, black spot on the side. Spines of the tibiæ whitish, tipped with black.

Length of female 1.4 to 1.6 inches; male much smaller.

This is a rather rare species, and is found only in the region of oak forests or groves, at least such has been the result of my observations.

35. ACRIDIUM EMARGINATUM. Uhler.

This species is closely allied to *A. alutaceum*, Harr., which it resembles very much.

Frontal costa sparsely punctured; lateral carinæ of the face slightly divergent. Pronotum densely, and on the anterior lobes coarsely punctured; posterior lobe expanding moderately. Elytra passing the abdomen one-fourth their length; nervules prominent. Posterior femora about as long as the abdomen. Prosternal point stout, cylindrical, obtuse, slightly bent backward. Cerci very broad, somewhat notched at the apex. Pulvilli remarkably large, oblong-ovate.

Color, a pale red-lish brown, tinged with green. A distinct, median, yellow stripe reaches from the vertex to the tip of the pronotum, and extends upon the suture of the elytra. A row of distant, black punctures on each margin of the frontal costa, and a row across the upper part of the clypeus. Palpi and antennæ yellow, and the sides of the pronotum sparsely sprinkled with yellow dots. Elytra translucent, pale reddish-brown; nerves darkest. Wings transparent, tinged with greenish yellow at the base; nerves and nervules dull yellow, darkest near the middle of the outer border, slightly tinged with red near the anterior border. Anterior and middle legs greenish externally; striped with black internally. Posterior femora pale green; upper margin of the disk marked with a row of black dots. Posterior tibiæ with the inner face black; outer face greenish-purple. Posterior margin of each abdominal segment marked with a ring of black dots.

Length of body of female 1.15 inches; male 1.25 to 1.4 inches.

This is a western species and but few specimens have been taken in this State.

36. ACRIDIUM AMERICANUM. Drury. (Fig. 10.)

Female.—Large size. Vertex hexagonal, with a central depression; frontal costa solid and somewhat prominent above the ocellus, sides nearly parallel. Eyes elongate oval, rounded behind, straight in front. Pronotum expanding at the posterior lobe; median carina but slightly prominent; humeral angles sub-distinct on the posterior lobe, obtusely rounded; anterior and middle lobes marked with minute shallow cells, each having a very minute tubercle in the centre; posterior lobe densely punctured; posterior margin about right-angled; apex rounded. Elytra and wings passing the abdomen one-third their length. Posterior femora reaching the apex of the abdomen. Prosternal spine large, curved backward and hairy.

Color.—Reddish-brown, with a slight vermilion tint. A yellow stripe extends from the vertex along the middle of the head and pronotum, and also upon the suture of the closed elytra as far as the tip of the abdomen. A dark brown line down the cheeks below the eyes. On the sides of the pronotum is a yellow stripe extending from the submarginal to the last cross-incision, directed a little obliquely downward; below this is a brown stripe; then a narrow yellow stripe directed obliquely upward; lower margin yellow.

Elytra opaque and reddish at base, rest semi-transparent; a narrow, white stripe on the lower margin, next the base; the disk and apical half marked with large cellular, fuscous spots.

Wings transparent; nerves at the base and inner portion yellowish-white, of the other portions black. Legs bright vermillion red. Posterior femora have a row of black dots along the upper and lower margins of the disk and one through the middle; spines of posterior tibiæ yellow, tipped with black. Each segment of the abdomen has a ring of dusky dots on its posterior margin.

Male.—Much smaller. Sub-anal plate prolonged, deeply notched at the apex; cerci very broad, straight and truncate at the apex.

Dimensions.—*f*—Length of body, 2 inches; elytra, 2.1 inches; posterior femora, 1.15 inches; posterior tibiae, 1.05 inches. *m*—Length of body, 1.7 inches; elytra, 1.65 inches; posterior femora, 1 inch; posterior tibiae 0.9 inch.

These dimensions are only intended to express the average, but there is less variation in this than in many other species in this respect.

Var. ambignum.—Very similar in size, markings, and carvings to *americanum* from which it differs chiefly and almost exclusively in the general color and time of appearance; being yellow or brownish-yellow, where the other is reddish-brown or vermillion. It is also somewhat more robust and appears much earlier in the season.

This species is found only in the southern half of the State. The red variety is somewhat common and occasionally quite abundant in limited localities. The yellow variety as a general rule is rarely met with and appears to be a more southern form of the species, which in this respect corresponds exactly with its congener *A. peregrinum*

TETTIGINÆ. (See Fig. 11).

The descriptions of the species of this group are omitted for the present because of the uncertainty as to what are true specific characteristics. It is my intention as soon as I have had an opportunity of examining sufficient material and arrive at a satisfactory conclusion as to what are really species and what varieties, to describe such as are found in Illinois.

LIFE-HISTORY OF LOCUSTS.

The entire life-history of but few species of the *Acrididae* have been studied, and these chiefly of the more destructive ones on account of the greater interest attached to them. Although the history of each species has some peculiarity in reference to it which is of value in economic entomology, yet, in a general sense, they are so nearly alike that the history of one will answer for that of all.

The female ovipositor, as we have already seen, consists of four horny valves, two which curve upward and two downward; with these, when ready to deposit her eggs, she forms a hole in the ground to a depth corresponding with the size of the species. The eggs are then deposited one at a time in this hole, placed in regular order so as to form an elongate oval mass. During the process a glairy white fluid is emitted which at length hardens and binds them together and encloses the mass giving it ultimately the form somewhat of a large bean. The hole above the mass is then closed with dirt intermixed with this fluid which, when it hardens, renders it partially at least impervious to moisture. The number of eggs deposited varies in the different species, a single mass deposited by the Rocky Mountain locust, (*C. spretus*), containing from twenty-five to thirty; the number deposited by some other species is considerably larger, and by some probably less. The eggs of all the species so far observed are elongate, cylindrical and slightly bent or curved; and when in the mass are placed in four tiers or rows, with the end in which the head will be formed, pointing upward, thus enabling the young insects readily to make their way to the surface of the ground. When the embryo is formed and ready to make its escape, it is enclosed, besides the outer shell, in a tough inner covering, which it does not wholly rid itself of until after it reaches the surface.

Whether the female deposits more than one mass is yet a somewhat disputed point; that some species, as *C. spretus*, *C. atlantis* and *C. femur-rubrum*, whose egg-pods contain only some twenty-five or thirty eggs, deposit some three or four of these pods, has been ascertained. It is probable that those species which deposit a much larger number in a mass, complete the work at one time. For example, Prof. Riley has counted as many as 171 eggs in one mass of *Caloptenus differentialis*; 120 to 130 in those of *Hippiscus phænicopterus*; and about 120 in those *Acridium americanum*.

The particular places selected by the females for depositing their eggs vary somewhat according to the species; but the form and char-

acter of the ovipositor would indicate, at least, that nature had intended them for boring into rather hard and compact soil; and some particulars in the hatching process also appear to require this; hence, as a general rule such situations are selected in preference to loose, sandy or moist earth. I think that most species, there are probably exceptions, dislike to deposit in thick grass sward. Zinnani, a close observing naturalist who lived at Venice over one hundred and fifty years ago, and who gave a full and accurate description of the process of egg-laying of the *Caloptenus italicus*, was of the opinion that the eggs deposited in the roots of grass were unfecundated. Subsequent observations have failed to confirm this opinion.

I have observed the female of the American locust boring into the hard compact soil of a well traveled street. In one instance I found the eggs of the common Red-legged locust in a piece of rotten wood, not combined in a mass; these were preserved and nearly or quite all of them hatched out.

When first hatched they are similar in form to and have all the organs of the perfect insect, except the wings, which are entirely wanting. In a few hours after exclusion they commence eating such appropriate food as they find at hand. Being generally great feeders they grow rapidly, and hence undergo repeated moults, usually from three to five before they arrive at the perfect state. At the second or third moult the wings make their appearance; then they are considered as having entered upon the pupa state. The *Calopteni*, or at least those that have been carefully studied, undergo another moult, the wings increasing in length, but not yet complete, and then by another change pass into the perfect state. As heretofore stated, there is no true or quiescent pupa state in the life-history of these insects; they continue feeding in all their stages. The length of time they remain in the preparatory states,—that is, from the time they leave the egg until they acquire full wings, varies according to the species, and also somewhat as to supply of food and the character of the season. The average length in the case of the Rocky Mountain locust is about seven weeks.

The process of moulting, as perhaps every reader knows, consists in casting off the outer integument or skin.

To those unacquainted with the appearance of the pupa state and the differences between it and the perfect state, it is often a puzzling question to decide whether a short-winged specimen is a perfect insect or a pupa. A little study will enable any one to determine this point with unerring certainty. The elytra of the pupa are in fact twisted around so that the faces and margins are precisely reversed from what they are in the perfect state; that which is to be the inner face is the outer face in the pupa, and the costal margin is the upper or anterior margin; the apical veins which curve upward in the closed elytra of the perfect insect curve down in the pupa. This peculiar arrangement will therefore enable any one soon to determine whether a short-winged specimen is a pupa or a perfect insect.

As a general rule the species found in our State appear to be single-brooded, but there are certainly some exceptions to this rule. The green-striped locust is certainly double-brooded in the southern part of the State as is also *C. atlantis*, and I am inclined to think that in the extreme southern portion *C. differentialis*—the Lubberly *Caloptenus*—is also two-brooded. On the contrary, the Rocky Mountain locust

certainly is not, as far south as this latitude; *Acridium americanum* is not in this State; *Truxalis brevicornis* is not; there is some uncertainty on this point in reference to *Caloptenus bivittatus*, and *C. femur-rubrum*. As a matter of course the determination of this question depends somewhat upon the latitude.

INJURIES BY GRASSHOPPERS.

As all the Acridians are vegetable eaters and continue to feed from the time they are hatched from the egg, through all their stages, as larva, pupa and perfect, it must necessarily follow that they are injurious, except where their attacks are confined to noxious or useless weeds. As a general rule they appear to feed on a large variety of plants; for example *Caloptenus spretus* is known to feed on almost every plant that comes in its way when migrating out of its native habitat; but some observations made in Colorado lead me to believe that when not pressed by hunger nor migrating it does not attack plants so indiscriminately. Although our common red-legged species (*C. femur-rubrum*) is a somewhat general feeder, yet it evidently eats in preference the grasses and prefers the open areas where the ground is rather dry and the grass not very rank. On the other hand *C. bivittatus* or the striped Caloptenus, and *C. differentialis* or the Lubberly Caloptenus prefer patches where the grass and weeds are rank and succulent, and appear to feed on rank weeds in preference to grass. At one place in Nebraska I observed a few years ago a peculiar variety of the Lubberly Caloptenus feeding almost exclusively on one particular weed. At another time I found the striped species feeding on and undergoing its moults among the leaves of horse-radish.

The favorite spot of the American Locust (*Acridium americanum*) in this vicinity is among the little willows and low bushes along a ravine that runs through a field near town, the borders of which are covered by a heavy growth of rank grass. At another point, a favorite spot is a thicket of low oak bushes, where grass and weeds are also abundant. It appears to feed on the grass and weeds, but is fond of flying up into the bushes and low trees when disturbed. This species, which does not extend further north than the middle of the State, appears in the perfect state about the first or middle of July—that is, the red variety or true American Locust; the yellow variety *ambiguum*, is much less numerous, and appears much earlier in the season. It is this variety which appears occasionally to pass the winter in the perfect state. It is a little remarkable that there are two precisely similar varieties of the very closely allied African migratory locust—*Acridium peregrinum*. In this case the yellow variety is the more southern, and possibly the same thing is true in reference to our species.

The Emarginate Locust—(*Acridium emarginatum*) appears to prefer, if it does not feed exclusively on the leaves of tall, rank weeds. I remember noticing at one time a large number feeding on some hemp growing on the bank of the Missouri river.

Oedipoda carolina or the Carolina Locust, so readily distinguished by its broad, black wings with a yellow band around the border, is fond of dry and somewhat barren spots, that are but partially or scantily covered with low vegetation. It does not appear to be a voracious feeder. I have never observed them congregated in any considerable number, except at one point, this was a vacant lot in Washington city, where for a number of days large numbers were collected. It is apparently innoxious, although common throughout the United States.

The Goathead Locusts, (*Tragocephala*) especially the Green-striped Locust (*Tr. viridifasciata* var. *virginiana*) and the Dusky Locust (same species var. *infuscata*) are so common that it is thought by many that they must be injurious. My observations have not confirmed this opinion. The Green-striped variety may occasionally be guilty of doing some slight injury to useful plants but never, so far as my experience extends to a degree to call for attention.

The Red-legged Locust (*C. femur-rubrum*) is beyond comparison the most injurious species that the agriculturists of Illinois have to contend with. The actual loss occasioned by all the other species combined, will fall far short of that occasioned by this species; unless it be that the Lesser Locust (*C. atlantis*) is much more abundant throughout the State than I think it is, and much more injurious elsewhere than in the southern part of the State, where it appears to most abound. If I may judge from collections of *Calopteni* made in the northern part of the State, it appears to be comparatively rare there. The readers of the Chicago daily papers will probably remember noticing an account during last summer (1879) of immense numbers of grasshoppers observed floating in Lake Michigan, between Milwaukee and Racine. They had been blown into the lake by a severe storm the day before they were observed floating there. Millions of them were thrown upon the beach near Racine, some of which Dr. Hay, the well-known scientist of Racine, Wis., had the kindness to procure and send me. The number sent was about one hundred and some two or three, more or less, yet not a single specimen of *C. atlantis* among them. In the collections made by Miss Smith, at Peoria, while she was acting as my assistant, I do not recollect to have observed a single specimen of *C. atlantis*, although carefully examining the large number of *Calopteni* preserved. Even in the central part of the State, where I made some examinations last summer, at points unusually troubled by locusts, I detected but few of this species; *C. femur-rubrum* and *C. bivittatus* being the prevailing species, the former largely predominating.

During some seasons *Caloptenus differentialis* becomes quite abundant. I remember two seasons when it appeared in great numbers in limited areas in the southern part of the State. In 1876 and 1877 several swarms of this species were observed in flight; one of these was observed at Champaign, and one at Cairo. I had the opportunity of examining in person a large number of the latter swarm, as I arrived in Cairo the next morning after they came down, and saw thousands of them yet in the streets and clinging to the sides of the houses.

Caloptenus bivittatus also occasionally develops in considerable numbers; it was very abundant in 1877 over a limited area south of Platte river near its mouth. But these species feed chiefly on weeds, and hence are not often injurious except where they enter vegetable or flower gardens, especially the latter.

Acridium americanum is occasionally quite numerous in certain localities in the southern part of the State, especially in excessively dry years. I remember one season when they did considerable injury; they attacked the corn, but this was too old and hard to be injured much by them. They attacked the gardens, and ate the onions to the very roots; wheat was also injured by them. They have been also known to take wing and migrate several miles in little swarms. A day or two before flying they may be observed congregating on the bushes, high weeds, fences, etc., showing signs of uneasiness and restlessness.

Warm, dry weather is favorable to the increase of locusts (grasshoppers,—and in this sense only do we use the term “locust” in this article); it is in the excessively dry seasons that they have always been the most injurious. Not only are they then most numerous, but vegetation has then the hardest struggle for existence, and every green spot is sure to be overrun by these hungry pests. In the sections where fall wheat is grown, it is sure, as soon as it peeps from the dry ground, to suffer from their attacks. As a general rule, instead of spreading indiscriminately over the fields, they usually commence on one side, taking the wheat clean as they go, or nearly so; at least, this is the usual habit of *C. spretus* and *C. femur-rubrum*, the latter, as heretofore stated, being the most injurious of the Illinois species.

REMEDIAL AGENCIES.

Natural agencies which assist in keeping them in check.—Fortunately, there are several natural agencies which have a tendency to prevent their increase. Of these, we may mention the following as the most important:

Climatic Influence.—Dampness is undoubtedly the most potent natural agent in keeping them in check.

Although they may have hatched out in excessive numbers, yet if a rainy season follows soon afterwards, they will to a very large extent be destroyed, and the invigorated vegetation will bid defiance to the feeble attacks of those that remain alive. Like other insects their breathing apparatus consists of a series of tubes that permeate the body, connecting with opening or breathing pores along the sides of the body, one on each side of a segment; the moisture taken in by inspiration in all probability produces disease, or at least in some way prevents the free passage of the air and thus lessens the vitality.

Excessive changes during winter also appears to have a tendency to destroy the vitality of the eggs. That those of the red-legged and

other allied species, which are somewhat boreal in their habits, can withstand a great degree of cold, is undoubtedly true, but they are certainly affected by sudden and considerable changes.

Insects and other animals that prey upon them.—The foes, especially of the same sub-kingdom, to which they belong, are numerous and often assist greatly in diminishing their numbers. At present I shall only call attention to the more important of these tiny aids.

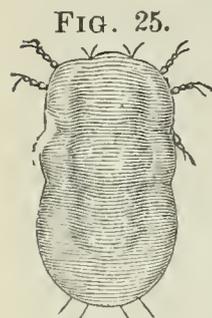


FIG. 25.
Young
Locust-Mite.

The Locust-Mite, (Trombidium locustarum) is one of the most efficient aids in keeping the locusts in check belonging to the invertebrate division. It is the same mite that Dr. LeBaron described in his Second Report as *Atoma gryllaria*. But his description relates only to the preparatory state, in which it possesses only six legs; the perfect form, as is the case with all (except possibly a very few species) mites, possesses eight legs.

When first hatched it is of an orange, or pale reddish color; ovoid in form with six comparatively long and apparently cumbersome legs; it is then very minute. When it reaches in the process of growth what may be called the full-grown larval state, it is very different in form; it is now more elongated and cylindrical, with two transverse constrictions; to use a rather ludicrous comparison, it resembles a microscopic potato. When it has reached the perfect state, it is of a deeper red, varying from orange red to scarlet. It is somewhat triangular in form with the angles rounded; being broadest in front and narrowing to the rounded posterior extremity, thickly covered with short hairs; and eight legs. The male differs from the female in being shorter, and comparatively broader in front.

Scientifically the species is distinguished by the following characters: "By the papal claw consisting of one large hook, with a second smaller one originating from its middle, and three stout spines from near its base, and by the thumb being of uniform diameter, armed with rather long hairs terminally, and reaching to or very little beyond its tip; also by a sunken, polished plate at the end of the body, dorsally."

In the perfect state this mite lives in the ground, subsisting on such food as it can find that is appropriate, especially insect eggs and probably minute larvæ. It sometimes proves quite destructive of locust eggs, of which it appears to be very fond. In its larval state it is chiefly found on grasshoppers, attached to the back immediately under the base of the wings, or along the larger veins of the wings near the base.

As shown by the First Report of the U. S. Entomological Commission there are quite a number of insects that in their perfect or preparatory states prey upon locust (grasshopper) eggs.

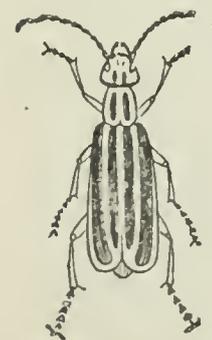


FIG. 26.
Blister Beetle.

Among these are two or three dipterous larvæ; several ground-beetles and their larvæ; the larvæ of melœ, and some of the Blister-beetles (*Epicenta*); and the larva of a Hymenopterous species.

In the same report quite a number of species that prey upon the Acrideans while the latter are in the young or perfect state, are described. These include a number of our Tiger and Ground-beetles; several species of Asilus-flies (Dipterous insects), which are long, slender-bodied flies of large size; several species of large wasps. But the most effi-

cient insect aids are doubtless the true parasitic flies. These are chiefly Tachina-flies, which deposit their eggs on the body of the locust, usually near the base of the wings, where they are out of reach, and where the external membrane is the most delicate. As soon as hatched the maggots eat their way into the body of their victim, where, as is usual with internal parasites, they feed upon the fatty portions without disturbing the vital organs; before entering they leave their host and go into the ground, where they remain until they reach the perfect state. These flies, to the casual observer, appear much like the common house-fly, but are slightly larger.

Another and very singular enemy of locusts, and acts as an internal parasite, is the Hair-worm, a species of *Gordins*.

Our space and time does not permit us to describe and give the history of these various parasites at this time. This will be done as occasion may require, when attention is called to particular species of locusts or other insects which they infest; at present I am confining this part of my report to a general account of the Illinois *Acrididæ*.

Remedies.—It is difficult to suggest any practicable remedies, except where these insects become so abundant as to justify the employment of means that will require considerable outlay.

Various means are used and several different machines have been invented for capturing and destroying the unfledged insects. But it seldom happens that the damage done by these insects is sufficient in this state to justify this expense, as it does in the more western states in contending with the migratory species of that region.

The best practical remedy for Illinois farmers is, as I conceive, of a wholly different character, but one that it appears impossible to put into operation. This is to protect more effectually insect-eating birds. I am aware that it is becoming almost unpopular, especially among a large number of our fruit-growers, to speak a word in praise of the birds. But even at the risk of being considered somewhat of an "old fogey," and of having "bird on the brain," I must contend that here lies one of the great remedial agencies for our farmers. I am willing to concede that the introduction of the English sparrow has proven a failure; but the evidence obtained in 1877 of the usefulness of birds in destroying locusts in the western states, is so conclusive that it ought to be sufficient to convince the most skeptical. That any general measure will not bear equally on all will always be true; that by preserving the birds our fruit-growers may and doubtless will suffer occasionally from their attacks is true; but in the long run I believe even they will be greatly the gainers.

Quite a large number of our insect-eating birds feed with avidity on the young locusts and destroy immense numbers of them. The yellow-headed Blackbird (*Xanthocephalus icterocephalus*), as well as other species of blackbirds, are perhaps the most efficient aids among the feathered tribes in destroying grasshoppers; and yet these are birds for which farmers have a particular dislike. Quails are also very useful in this respect. But strange as it may appear a large majority of our farmers will willingly pay out fifty or a hundred dollars or even more in protecting their crops by destroying insects with machinery or applications, rather than suffer half that loss by birds, which would do the same work for them and far more effectually. The reason for this is that in the one case the destruction of the insects is apparent to them, a mere matter of ocular demonstration,

while in the other they are destroyed in such a way that it is not apparent to them, and hence, as the insects do not become abundant they cannot be convinced that the birds have prevented it.

This much disputed question will never be satisfactorily settled until it is practically tested; and the only way to do this is for a county or several contiguous counties to adopt a bird-law that will effectually protect all the birds throughout the entire year, and continue this for four or five years until sufficient time has elapsed to see the result. This plan and this only, will, as I believe, ever test the matter satisfactorily. To attempt to kill off a certain species and preserve others, is equivalent to devoting all to destruction, for those that are not killed will be driven off.

Domestic fowls are great aids also in destroying locusts, as they are very fond of them; but when we suggest this remedy, it generally excites a derisive smile, for the thought comes up in the mind of the farmer who has his hundreds of acres in cultivation, "What can a few chickens do toward destroying the grasshoppers on 160 or 320 acres of meadow and wheat?" We answer but little, *very little*. Why then do we suggest such remedies? Because the God of Nature has not endowed us with miraculous powers, by which we can, with some talismanic word or token, annihilate the insect hordes he has allowed to prey upon your crops. We are students of Nature and study Nature's laws, so that by bringing them to light we may show you where they have been violated, and how to restore the balance that Nature adjusted between her creatures and her various forces. You may be able to erect a barrier that will turn the stream from your land, but still the waters will flow and beat against the barrier and as soon as it is removed or broken down, in they will flow upon you. By acting in accordance with the laws that govern fluids, as, for example, by opening a new channel you may use the natural forces as assistants to keep your land always free from the overflow.

So it is in reference to the laws that govern insect life; if insect enemies are destroyed and the food upon which they live is multiplied and massed, as a natural consequence their numbers will be proportionally increased. Under these circumstances there will be against this evil but two offsets—one is that with their increase it generally follows that after a time the true parasites that prey upon them, if any, will increase in like proportion—the other consists of such means of destruction as man may be able to devise. If the species is not subject to the attacks of parasites, as appears to be true of the chinch-bug, then man will have to wage a continual warfare with these tiny foes. As entomologists, we study the life, history and habits of the species, in order to inform the agriculturist the most propitious time for, and most effectual means of destroying them. But so long as the conditions which cause their increase continue, so long must the warfare be carried on. We are led, therefore, to speak of the higher law that governs these things, and the more comprehensive and more permanent remedy which may be adopted, but with little hope, it is true, that it will be put in practice. It is to cut up the large farms and fields into smaller ones and introduce a more diversified method of farming. I am more and more led to believe that the use of machinery to the extent that it is now employed in farming is not really beneficial, at least to the mass of the people. I do not believe in

running to extremes in either direction or arraying one class of industry against another, for this is inimical to the general welfare, and retards progress in enlightenment, but to so modify and proportion them as to produce the most beneficial results. If, a plan could be devised by which owners of large farms could cut them up and divide them among tenants, in parts no larger than the labor of each tenant could properly cultivate, the result would be far more beneficial to the masses, and the destruction by insects would be far less than the present method of working these large farms by machinery. This would have a tendency, which is largely growing upon us, and bringing with it a train of evils, to gravitate the laboring populations to the cities. But the question which governs in this matter is, will it pay? and so long as it is answered in the negative, so long will the present tendency continue. As the warfare with insects must therefore go on as it has done, only growing fiercer and fiercer with each returning season, we must, as our duty requires, court nature in order to persuade her to yield up her secrets that we may be enabled to devise new means of destroying the hosts of lilliputian foes that are constantly swelling their ranks by the addition of fresh cohorts.

I do not deem it necessary at present, as heretofore intimated, to enter upon a full description of the various means which may be employed to destroy locusts. If they should greatly increase, or the migratory species break over the bounds nature has hitherto fixed to its migrations, it will then become necessary for our farmers to be fully posted in reference to the best means of defense.

Is it likely that the Rocky Mountain locust will ever invade Illinois, to an injurious extent?

A thorough and elaborate discussion of this question would require more space and time than is at this time at my command; nor is it necessary to enter upon so complete an investigation, until some reason appears to render doubtful the conclusion arrived at: *that it will not.*

Mr. Walsh, our former able entomologist, was the first to reach this conclusion, and subsequent facts and experience have tended strongly to confirm it; but at the same time these facts have demonstrated that the reasons on which he based this conclusion were erroneous.

His idea was that the reason they did not and could not invade Illinois was, that the limits reached by them in their eastern flight—about or a little east of the middle of Iowa—marked the extent of their powers of flight. "It would be absurd, for example," he argues, "to imagine for one instant that a grasshopper army, starting from the Rocky Mountains, could in one season fly all the way to France or England, or even as far as the Atlantic seaboard of the United States." He appears to have entertained that these armies came from that part of the Rocky Mountain range immediately west of us, and came in a more or less direct east course. He estimates the greatest extent of their migrations at about 550 miles, and supposes it impossible for them to extend them to 700 miles. Abundant evidence acquired since that time shows that the general course of the invading swarms is southeast, and that the area from which those come that invade Iowa and Nebraska, lies in the northwest, chiefly in Montana and British America; not within, but east of the Rocky Mountain range,—the mountain range is also a source of supply. But I now

allude to the swarms visiting eastern Nebraska and the western half of Iowa.

It has further been clearly ascertained that their migrations in a single season may, and occasionally do, extend not only 700 miles, but as much as 1,000 miles; and so far as their powers of flight and endurance of the fatigue of migration is concerned, there appears to be no reason why, with favorable winds and weather, they could not reach even the Atlantic coast. I once held a similar view to that advocated by Mr. Walsh, but a somewhat thorough investigation of locust flights has served to convince me of my error in this respect. There can be little doubt that swarms have traveled in a single season from the confines of British America to Texas. So far then as the distance is concerned Mr. Walsh was evidently in error; yet so far as his conclusion is concerned there does appear to be some law that limits their migrations toward the east. But the possibility of their crossing the Mississippi does not depend as he thought upon the elevation of a mountain range east of the Rocky Mountains, but upon a change in climatic conditions. Let Iowa and Minnesota become as dry and barren as the plains west of them and the locusts will be as certain to pour down upon the fields and prairies of Illinois as effect follows cause. If the thousands of little lakes in the western and southern part of Minnesota should be dried up or drained, then will this arid condition be brought about. With the present climatic conditions Illinois' fields and meadows will never become a prey to these migrating hordes, to the meteorologist must the question therefore be referred for solution.

APPENDIX.

Some cuts, which were ordered for my Second Report, were accidentally omitted. For the benefit of those who have that report and also receive this, I insert them here.

THE LANCE RUSTIC. (*Agrotis ypsilon*.—Rott.)



FIG. 27.

For a description of this species the reader is referred to pages 93 and 210 of my Second Report.

THE GOTHIC DART. (*Agrotis subgothica*.—Haw.)

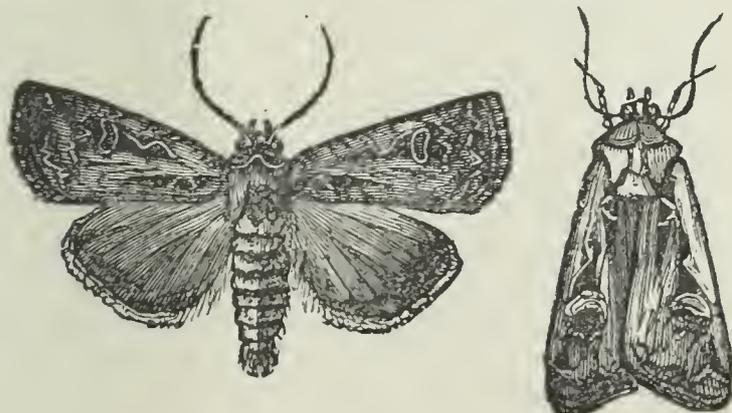


FIG. 28.

A description of this species will be found on pages 89 and 204 of my Second Report.

THE STALK-BORER. (*Gortyna nitela*.—Guen.)

FIG. 29.

A full account and description of this well-marked pernicious species is given on pages 112 to 114, Second Report.

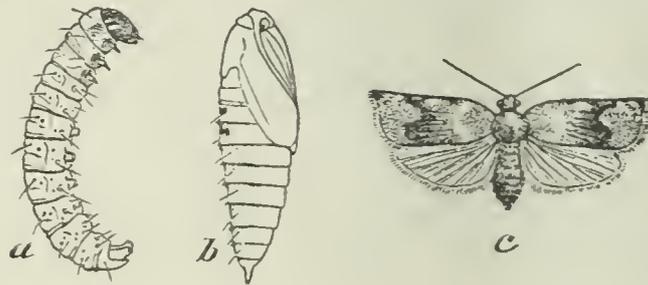
THE OAK-LEAF TORTRIX. (*Argyrolepia quercifoliana*.—Fitch.)

FIG. 30.

The habits, history and description of this species will be found on pages 114 to 120 of my Second Report.

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